



HANDBOOK OF COGNITIVE ARCHAEOLOGY

PSYCHOLOGY IN PREHISTORY

Edited by TRACY B. HENLEY,
MATT J. ROSSANO, and EDWARD P. KARDAS



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The remains that archaeologists uncover reveal ancient minds at work as much as ancient hands, and for decades many have sought a better way of understanding those minds. This understanding is at the forefront of cognitive archaeology, a discipline that believes that a greater application of psychological theory to archaeology will further our understanding of the evolution of the human mind.

Bringing together a diverse range of experts including archaeologists, psychologists, anthropologists, biologists, psychiatrists, neuroscientists, historians, and philosophers, in one comprehensive volume, this accessible and illuminating book is an important resource for students and researchers exploring how the application of cognitive archaeology can significantly and meaningfully deepen their knowledge of early and ancient humans. This seminal volume opens the field of cognitive archaeology to scholars across the behavioral sciences.

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Psychology in Prehistory

*Edited by Tracy B. Henley,
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CONTENTS

<i>Editors' introductory remarks</i>	ix
<i>Archaeological foreword: Cognitive archaeology and the prehistory of mind</i> Trevor Watkins	x
<i>Psychological foreword: Cognitive archaeology – beyond just-so stories and WEIRD psychology</i> Valerie E. Stone	xix
<i>Acknowledgements</i>	xxvi
<i>List of contributors</i>	xxix

PART I

Prehistory from the perspective of physiological and developmental psychology	1
1 Introduction: what would Wundt think? <i>Edward P. Kardas and Tracy B. Henley</i>	3
2 Before, after, and alongside the excavation: how to think about the evolution and history of physiology and development <i>Melvin Konner</i>	19
3 Life history evolution in hominins <i>Jon Oxford and David C. Geary</i>	36

4	Evolution of hormonal mechanisms for human family relationships <i>Heather Habecker and Mark V. Flinn</i>	58
5	The evolution and development of morality <i>Dennis L. Krebs</i>	86
6	In search of baselines: why psychology needs cognitive archaeology <i>Darcia Narvaez</i>	104
7	Play: a neglected factor in ritual, religion, and human evolution <i>Gordon M. Burghardt</i>	120
PART II		
	Prehistory from the perspective of cognitive psychology	135
8	The origins of generativity <i>Michael C. Corballis</i>	137
9	Three stages in the evolution of human cognition: normativity, recursion, and abstraction <i>Ceri Shipton</i>	153
10	The evolution of learning and memory in humans: comparative perspectives on testing adaptive hypotheses <i>Mark A. Krause and Crickette Sanz</i>	174
11	Reconfiguring Natural Semantic Metalanguage for a deep cognitive archaeology <i>Horacio Fabrega, Jr.</i>	196
12	Exploring the psychological basis for transitions in the archaeological record <i>Liane Gabora and Cameron M. Smith</i>	220
13	The cognitive mechanisms deriving from the Acheulean handaxe that gave rise to symmetry, form, and pattern perception <i>Derek Hodgson</i>	241

- 14 The role of expert technical cognition in human evolution 261
Thomas Wynn and Frederick L. Coolidge

PART III

Prehistory from the perspective of social psychology 285

- 15 Key cognitive preconditions for the evolution of language 287
Merlin Donald
- 16 The human social mind and the inextricability of science and religion 296
Mark Nielsen
- 17 Markers of “psycho-cultural” change: the early-Neolithic monuments of Göbekli Tepe in southeastern Turkey 311
Oliver Dietrich, Jens Notroff, Sebastian Walter, and Laura Dietrich
- 18 How ritual made us human 333
Matt J. Rossano
- 19 The role of egalitarianism and gender ritual in the evolution of symbolic cognition 354
Camilla Power
- 20 Norms and their evolution 375
Kim Sterelny
- 21 Power, play, and interplay: the psychology of prehistoric sexuality 398
Timothy Taylor

PART IV

Prehistory from the perspective of personality and clinical psychology 413

- 22 Domestic fire, domestic selves: how keeping fire facilitated the evolution of emotions and emotion regulation 415
Terrence Twomey

Contents

23	Psychology in archaeology: the secret society case <i>Brian Hayden</i>	431
24	The archaeology of madness <i>David S. Whitley</i>	451
25	The prehistory of psychoactive drug use <i>Edward H. Hagen and Shannon Tushingham</i>	471
26	The lure of death: suicide and human evolution <i>Nicholas Humphrey</i>	499
27	From corpse to symbol: proposed cognitive grades over the long-term evolution of hominin mortuary activity <i>Paul Pettitt</i>	512
28	Afterword: psychology and archaeology – the past’s long reach <i>Matt J. Rossano, Tracy B. Henley, and Edward P. Kardas</i>	526
	<i>Index</i>	535

EDITORS' INTRODUCTORY REMARKS

From our earliest “pitch” we envisioned that this book would open with two forewords – one each that would speak to the interplay of psychology and cognitive archaeology from the perspective of those two disciplines. Think of these then as a matched pair that sets a tone and context for the 28 content chapters that follow – perhaps more of an intellectual “appetizer” than traditional forewords.

Each of us (Henley, Rossano, and Kardas) had done several previous books, and so understood that every project has a unique life of its own. That is perhaps especially true for a large, edited anthology, where several dozen contributors are centrally involved. That said, the life of this volume has been an especially good one. No doubt it was the timely lure of the project concept – an interdisciplinary book that would span cognitive archaeology and psychology – that made things unfold so well. Indeed, as is inevitable with a large and elongate effort such as this, we had five contributors who at some point felt they would have to withdraw to attend to other matters. Yet, in the end, we were able to retain all but one of them, because they never lost interest in the work.

In close, we trust that if you are reading these remarks you will absolutely be delighted with what follows. And that begins with our paired set of forewords.

Respectfully,

Tracy, Matt, and Ed

COGNITIVE ARCHAEOLOGY AND THE PREHISTORY OF MIND

Trevor Watkins

Like psychology, archaeology is a relatively recently emerged discipline. Although archaeologists have always worked collaboratively with specialists in other fields, it is only in recent decades that some archaeologists have had the confidence to expand the scope of the discipline to encompass ideas of a cognitive archaeology. Around two hundred years ago the first archaeologists began to differentiate themselves from antiquarianism (an interest in and the collection of antiquities for their own sake). From the associations in which artifacts from Denmark's pre-Christian past had been found, Christian Thomsen defined three successive ages, stone, bronze, and iron, that for the first time gave a chronological framework to the abyss of the prehistoric past. As geologists were beginning to conceive something of the enormity of the geological timescale, excavators digging in cave deposits recognized that chipped stone artifacts were evidence of humans living alongside extinct animal species of an almost unimaginable geological past. By the time that Darwin published his theory of evolution in the middle of the nineteenth century, the first fossil Neanderthal remains were causing further difficulties: There had been human forms that were not *Homo sapiens*, which implied that modern humans had evolved on a geological timescale from earlier, extinct species of the genus *Homo*. For the first time, people encountered the problem of thinking about ourselves as another animal species that had evolved from a common ancestor with the great apes. Was it possible to imagine that the story of how we humans have come to be as we are could be worked out from chips of flint, sherds of pottery, corroded bronze tools, hearths in caves, burials under mounds, and standing stone monuments such as Stonehenge?

By the middle of the twentieth century, prehistoric archaeology was developing new collaborations (with palaeoenvironmental scientists, palaeo-botanists, palaeo-zoologists, physicists interested in the analysis of materials, and physicists who were developing radiocarbon and other radio-metric dating techniques); and archaeologists were also developing a theoretical understanding of the relationship between

the surviving material culture that formed their primary data and the human societies whose way of life was in part represented in those physical remains. Gordon Childe wrote a new kind of history of prehistoric Europe, based on a carefully thought notion of cultural groups:

We find certain types of remains – pots, implements, ornaments, burial rites and house forms – constantly recurring together. Such a complex of associated traits we shall call a “cultural group” or just a “culture.” We assume that such a complex is the material expression of what today we would call “a people.”

(Childe, 1929, p. v)

He was reacting against the work of the German archaeologist Gustav Kosinna, who believed that he could identify the near-continental range of the ancestors of the ethnic Aryans (the ancestral Germans) by means of their prehistoric pottery. Kosinna’s ideas were eagerly adopted by German nationalists, and the Nazi government funded archaeological work in support of its imperial ambitions.

It is not surprising that archaeologists of the post-World War II period were cautious, empirical, and pragmatic in the interpretation of prehistoric material. In the early 1950s the senior British archaeologist Professor Christopher Hawkes of Oxford University was invited to speak at a conference on archaeological method and theory held at Harvard in 1953. The idea was widespread that there was a strong ecological relationship between the tools and equipment with which a people made their living and the environment in which they lived. In the paper written from his conference talk Hawkes wrote:

If material techniques are easy to infer to, subsistence–economics fairly easy, communal organization harder, and spiritual life hardest of all, you have there a climax of four degrees in reasoning . . . human subsistence–economics differ from animal more obviously, but only (again logically speaking) in the amount and degree of forethought which they involve; human communal institutions next transcend the animal level very considerably; and human spiritual life transcends it altogether by this sort of archaeology. What it seems to offer us is positively an anticlimax: the more human, the less intelligible.

(Hawkes, 1954, p. 162)

The general view was that, without the written record on which history was based, archaeology should stick to technological, economic, and environmental aspects, with perhaps some simple inferences concerning the social life of past societies. While there was plentiful evidence in both North America and Europe of prehistoric ritualized human burial, and elaborate and costly monuments, it was thought inappropriate to speculate on what was in the minds of those who had buried their dead or labored to build those monuments. And, of course, since the late nineteenth

century there was an increasing number of examples of painted caves and three-dimensional female figurines that because of their geological context had to be dated to the Palaeolithic–Pleistocene period. How could they be analyzed, except by the speculative application of pseudo-anthropology (e.g., hunting magic or fertility symbols) and Western art-historical methods?

In the 1960s a new generation of archaeologists sought to define a more scientific understanding of human culture and a new goal of investigating the processes of cultural evolution. The intellectual leader of the processualist movement, Lewis Binford, wrote of culture as “the system of the total extrasomatic means of adaptation” (Binford, 1965, p. 209). The key words were “cultural evolution” and “adaptation”; that is, the human story was to be scientifically investigated in terms of culture as a specifically human tool for adaptation to (physical) environment. While the process whereby mobile hunter–gatherer bands became sedentary farmers was a subject wholly appropriate for investigation, their ideology, rituals, or art were elements of a group’s culture that were either inaccessible or arbitrary, and not of serious concern.

The processualists modeled human culture as a cultural system made up of interacting sub-systems such as technological, economic, social, and ideological. Kent Flannery (1972), one of the leading figures in the movement, described cultural eco-systems as the means by which humans adapt to their environment through exchanges of matter, energy, and information, but he complained that most of his colleagues focused on the ecological adaptations to the physical environment and neglected the exchange of information. Flannery was co-directing with Joyce Marcus a major field project in the Oaxaca valley of central Mexico, where they were able to investigate a series of archaeological sites that documented 10,000 years of cultural history, ranging from hunter–gatherer cave sites at one end of the story to the rise and fall of Zapotec civilization and its impressive urban center, Teotihuacán. Their problem was to explain in particular the rise of a major civilization that was clearly much more than a series of technological or economic adaptations within an apparently stable Holocene environment. As the city of Teotihuacán made clear, phenomena such as ritual, religion, cosmology, and iconography were central to its existence and the lives of its people; and Flannery and Marcus set out in a pioneering study to explore how ritual and Zapotec cosmology could be integrated into a human eco-systems analysis of the rise of Zapotec civilization (Flannery & Marcus, 1976). Since that time there has been an increasing amount of focus on the role of religion, rituals, and cosmology by archaeologists engaged in field research on sites of the Formative period in North, Central, and South America (that is, the period from the establishment of settled village life based on farming leading up to the establishment of large-scale political states, kingdoms, or empires) (e.g., the recent edited volume, Barber & Joyce, 2017).

The pioneer in Britain has been Colin Renfrew, of the same generation as Flannery and the American processualists. Signaling his membership in the processualist school, Renfrew has occasionally referred to cognitive archaeology as cognitive-processual. Like Flannery, Renfrew’s early work was on the emergence of the first state-level societies, but in his case it was the rise of the first European civilizations

in Greece and the Aegean. His excavations in the early 1970s at the site of Phylakopi on the Aegean island of Melos, where there was known to be a long sequence covering from the (formative) third to the Mycenaean civilization at the end of the second millennium BC, produced a small shrine complete with a rich series of finds associated with the cult. The title of his publication of the investigations (*The Archaeology of Cult: The Sanctuary at Phylakopi*) shows how the discovery of the shrine and its cult equipment had focused his thinking on how to use material evidence in the quest to understand the use and perhaps even the meaning of religious symbolism (Renfrew, 1985). Renfrew used his inaugural lecture at Cambridge University in 1982 to call for an ambitious and optimistic expansion of the archaeological inquiry, a program for cognitive archaeology (*Towards an Archaeology of Mind*, Renfrew, 1982). Through the Macdonald Institute for Archaeological Research, set up in Cambridge under his leadership, Renfrew has been able to master-mind a series of publications derived from Cambridge conferences, and to see the establishment of a journal, the *Cambridge Archaeological Journal*, to serve as a vehicle for symbolic, social, and cognitive archaeology research. Religion, ideology, and the symbolism of rituals and imagery have continued to be fields of interest for archaeologists and others, mostly in the context of relatively recent times, whether prehistoric (and therefore pre-literate) or early historic (where there may be surviving but generally uninformative texts).

In terms of the time span of the human story (at least two or three million years), the interests of archaeologists like Colin Renfrew, Kent Flannery, and Joyce Marcus concern quite recent times, when the *Homo sapiens* involved were physically, biologically, and genetically no different from ourselves. The social worlds in which they lived and the religious ideologies of their social worlds would seem very strange to us, but so would the social worlds and ideologies of most contemporary non-Western peoples. While there has been much work on the archaeology of cult, ritual, religion, cosmology, and ideology, there is another dimension that leads to a rather different kind of cognitive archaeology: This kind of inquiry stems from the basic question of what differentiates the earliest humans from their closest biological relatives, the great apes.

Following the revelatory discoveries by Louis and Mary Leakey in the 1950s and early 1960s of new hominin fossils in the stratification exposed in the sides of Olduvai Gorge, part of the Great Rift Valley in Tanzania, many more archaeologists (aka palaeoanthropologists) expanded the geographical range of the explorations in East Africa, and soon began to add more and more fossils. With the advent of radiometric dating methods, the time depth of human evolution was expanded from the cautious estimates of a few hundred thousand years to more than three million years. The oldest and earliest fossils were difficult to identify as members of the genus *Homo*; they walked upright, and lived in open savannah landscapes, unlike their three closest living relatives. While their brains were very similar in size to those of the great apes, their teeth were those of omnivores, rather than herbivores. Gradually it became possible to date places where the activities of the simplest stone toolmaking and use were concentrated and associate those sites with contemporary fossil hominins. At least by the early 1970s, some investigators saw the potential to seek

out and document the story of human evolution in terms of the social lives of the earliest hominins and their evolving human behaviors. The careful examination of locations that represented clusters of the simplest kinds of chipped stone implement showed that some of the associated fragments of animal bone had cut marks characteristic of butchery and the stripping of meat from the bone; it could be reasonably inferred that such sites represented a place to which a group of early hominins brought back to the group's campsite the carcasses or parts of animals that had been hunted or scavenged, where the meat was butchered, shared, and eaten. Group food-provisioning and food-sharing are not found among the great apes, but are typical of the earliest hominin toolmakers (e.g., Isaac, 1978). And such social behavior supposes a psychology that differentiates hominins from contemporary great apes.

To move forward with such studies it was clearly necessary to attempt to bring together material and ideas from various disciplines, one of which was archaeology. Any theory that claimed to explain the evolution of humans as they have diverged from their nearest primate relatives needs the archaeology of the Pleistocene-Palaeolithic and the early Holocene at the very least to provide material and contextualized evidence and to calibrate its timescale. The evolutionary theory of the psychologist Merlin Donald focused on the relationship between modes of communication – gesture and mimetics, spoken language, and most recently external symbolic storage in the form of written language – and the scale and complexity of human societies (Donald, 1991, 2001, present volume). A number of archaeologists found Donald's idea of external symbolic storage exciting, and Colin Renfrew invited him to a Cambridge conference to join a group of archaeologists who sought to deploy his theory in archaeological contexts; his contributions to the conference and its publication sandwiched the archaeologists' responses to his theory, first, summarizing his ideas, and, at the end, responding to his archaeological encounter (Donald, 1998a, 1998b). Working in the opposite direction (across the Atlantic and across the disciplines), the British archaeologist Steven Mithen published a landmark book, *The Prehistory of the Mind* (Mithen, 1996). His jumping-off point was the current evolutionary psychology theory of Tooby and Cosmides (1992), who were arguing that the human mind had evolved over time a set of specific neural tools adapted to solve problems in particular domains; he interpreted their ideas within the framework of the archaeology of the hominins, and in a novel way reached interesting conclusions concerning the emergence of a generally modern human mind around fifty thousand years ago, within the lifespan of *Homo sapiens*.

At much the same time, the French prehistoric archaeologist Jacques Cauvin wrote a very different kind of book that has been widely read, and whose ideas have been both influential and provocative (Cauvin, 1994). Cauvin interpreted the emergence of Neolithic symbolism and the adoption of farming practices in Southwest Asia in terms of a “psycho-cultural” revolution; as his title clearly indicated, he believed that the birth of the idea of powerful, anthropomorphic gods preceded and led the way to the beginnings of farming (*Naissance des divinités, naissance de l'agriculture: la révolution des symboles au Néolithique*. Cauvin, 1994). The original French book sold in the tens of thousands (therefore reaching many more readers than

there are Francophone archaeologists and archaeology students). When it appeared in an English edition (Cauvin, 2000), it stirred another wave of Anglophone interest, and it has remained in print till today. I was privileged to be one of his friends, and was particularly glad to produce the English text; I knew that it would make me read and think about the text and his ideas. I was able to discuss (correct and improve) the translation with him before it went to the publisher, but that was not the time to ask him any of the questions that I had; Cauvin's style was allusive, but he almost never gave straightforward references that indicated the sources of his thinking. Sadly, he fell suddenly and fatally ill shortly after the English publication: What he meant by a "psycho-cultural" revolution and his ideas about symbolic representation and the evolution of religion would be a juicy topic for research, for Cauvin had originally studied philosophy, and his thinking was certainly not the imaginative speculations. Cauvin's work has certainly influenced Ian Hodder's thinking (e.g., Hodder, 2011a), as it has mine and a number of other archaeologists seeking ways to understand the cultural expression of ideas in symbolic representations and practices in early Holocene societies.

Going interdisciplinary on your own is both difficult and risky; the solo researcher, who may not have the necessary depth of understanding, risks damning criticism from specialists in the disciplines into which he/she has ventured. The solution to the problem of managing interdisciplinary research of the kind that is needed, it seems, is to form alliances on a project that can attract funding in seven digits, and work together over a period of years. The evolutionary psychologists Tooby and Cosmides indeed recommended a collaboration that brings together specialist knowledge in evolutionary biology, cognitive science, behavioral ecology, psychology, hunter-gatherer studies, social anthropology, primatology, and neurobiology; groups currently working together also include philosophers and economists.

Since the late 1980s the evolutionary psychologist Robin Dunbar has been a leading figure in the study of the social behavior of hominins among the primates, developing what he has called the social brain hypothesis (Dunbar, 1997, 1998). Between 2003 and 2010, together with two archaeologists who were specialists in the Palaeolithic period, he co-directed a major interdisciplinary research project (*Lucy to Language: The Archaeology of the Social Brain*) (Dunbar, Gamble, & Gowlett, 2010, 2014; Gamble, Gowlett, & Dunbar, 2014). Led by researchers who were expert in different fields – the palaeoanthropology of hominin evolution, Palaeolithic archaeology, and evolutionary psychology – and supported by the work of post-doctoral and doctoral researchers, some of whom brought additional skills, the project has produced a powerful account of the social and cognitive evolution of the genus *Homo* that sets in context our species *Homo sapiens*.

Two recent books by authors who have been working with colleagues (including archaeologists) in this interdisciplinary area for at least two decades document the progress that has been made in this new century. Joseph Henrich says of himself that he integrates ethnographic tools from anthropology with experimental techniques drawn from psychology and economics. At the outset of his book, he declares that he is "more than ever convinced that to understand our species and to build a science

of human behavior and psychology we need to begin with an evolutionary theory of human nature” (Henrich, 2015, p. xii). And he summarizes the central point learned from his collaborative research thus: “[C]ultural evolution became the primary driver of our species genetic evolution. This interaction between cultural and genetic evolution generated a process that can be described as autocatalytic, meaning that it produces the fuel that propels it” (Henrich, 2015, p. 57). He describes cultural evolution as a process of “self-domestication,” whereby humans have become remarkably prosocial, docile rule-followers, well adapted to living in large-scale, intensively interactive communities, and, at the same time, uniquely skilled in the social learning opportunities that our cultural worlds have been built to promote.

Kevin Laland emphasizes throughout his book the importance in human evolution of the development of cognitive skills in cultural innovation and the capacity for cumulative culture within the cultural niche (Laland, 2017). From the outset, he highlights “the significance of accelerating cycles of evolutionary feedback, whereby an interwoven complex of cultural processes reinforce each other in an irresistible runaway dynamic that engineered the mind’s breathtaking computational power” (Laland, 2017, p. 3); in the closing section of the book, he summarizes his conclusion that there were “a broad array of feedback mechanisms in the human lineage, through which key elements in human cognition and culture accelerated together in a runaway, autocatalytic process” (Laland, 2017, p. 321). Both programs of research (and there are other groups and individuals who would broadly agree) have developed accounts in which the central role is the evolution of human culture; both talk in terms of the distinctiveness of cultural niche construction, and the human capacity for cumulative culture. We have moved on from models that seek to relate material archaeology to the cognitive mechanisms of the evolving human mind; the human mind is not something that can be isolated from the human body, agency, and the scaffolding of culture; the knowledge and skills of the archaeologist are still essential to the mix, but the disciplinary mix has become much richer.

What we (archaeologists) have learned so far is that we need to know more about evolutionary psychology, just as evolutionary psychologists need to work with archaeologists who can contribute the material evidence that can turn hypothetical models into sound theories. But it requires more than a partnership between representatives of those two fields. In this regard, the increasing support for the ideas of the extended mind (Clark & Chalmers, 1998; Menary, 2010a), or, in other forms, embodied, embedded, or enacted cognition (Menary, 2010b), are also important. They fit well with archaeological theories of materiality (our dependencies on and the affordances of the material world) or entanglement (the complex webs of relationships between humans and things, things and humans, humans and humans, things and things). Ian Hodder has been a leading archaeological theorist since the 1970s; in a recent paper he has attempted a synthesis of archaeological theory, which seeks to bridge the various factions in the somewhat chaotic and fast-moving field (Hodder, 2011b). In my more than half-century of experience, archaeology has become more and more exciting; I have learned that we are still on the steep start of a learning curve in terms of unexpected discoveries that require us to re-think our ideas and new

ideas that encourage us to re-shape our models of the past. Archaeology has always been enjoyable as a practice, because it requires stimulating teamwork and rewarding collaboration with scientists from other disciplines. But, by working in collaboration with colleagues from a new range of disciplines, we can see that Christopher Hawkes' mid-twentieth-century pessimism about our ability to reach into the social life, ideas, and ways of thinking of nonliterate societies has been overcome. Hawkes was still in post at Oxford when Colin Renfrew was elected to the Disney Chair at Cambridge; he reviewed the slim publication of Renfrew's inaugural lecture, *Towards an Archaeology of Mind*, skeptical of its ambitious optimism (Hawkes, 1983). Archaeologists and evolutionary psychologists need to talk to each other and know about each other's interests and disciplinary abilities, and recognize each other's limitations and constraints. But it is thanks to wider collaborations among archaeologists, evolutionary and cognitive psychologists, neuroscientists, evolutionary theorists, anthropologists, behavioral ecologists, primatologists, and philosophers that we have begun to understand a great deal that used to be thought inaccessible to science.

I want to conclude with remarks that stem from my life in archaeology, a discipline that is based in the concept of culture, even if that underpinning is almost unconscious: archaeologists work with cultural packages, whether it is the chipped stone industry at a particular site, or the total material cultural package that has been recorded for a region at a particular period. All our prehistoric archaeological materials are cultural products, just as, in the historic period, the inscriptions, texts, and books are cultural products. An individual human with an individual human mind may have made a particular Acheulean handaxe, but, no matter what their cognitive skills were, that toolmaker was reliant on the cultural knowledge and skills acquired and practiced within a particular cultural context, which had also formed and constrained his/her norms of behavior and ways of seeing the world. The conversations between us cannot be simply directed to explain the traces of some past behavior in terms of the psychology of people of that time: We need to think in terms of how cognition and cultural context interact with one another. In general, we should be prepared to "boldly go"; but we are still on the steep beginning of a challenging learning curve, and we can expect that much of what is being written today will soon prove to have been ill-founded hypothesis or plain error. Working together, however, over the last 25 to 50 years there has been remarkable progress; we now know so much about our evolutionary ancestors, and therefore about ourselves, the nature of our minds, and how we live with and through the people and things with which we populate our worlds.

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COGNITIVE ARCHAEOLOGY – BEYOND JUST-SO STORIES AND WEIRD PSYCHOLOGY

Valerie E. Stone

“That’s a just-so story.”

Such accusations have long been leveled at scholars of human evolution. Cognitive archaeology, bringing psychology, neuroscience, genetics, anthropology, and archaeology together, will be certain to face the same accusation from some quarters. What allows evolutionary scientists to escape such a label for our work, however, is the use of the scientific method, the method of strong inference (Platt, 1964).

In strong inference, one looks not only for evidence that is consistent with one’s hypothesis, but also for evidence that is inconsistent with alternative hypotheses (Platt, 1964). Just-so stories, thus, are not scientific because they look only for what is consistent with observation, without making the extra effort to compare observations to the predictions of alternate accounts.

Concerned as it is with understanding our species’ past, human archaeology lies somewhere between history and experimental science. Scientists’ study of humans’ prehistoric past is distinct from approaching history as a liberal arts subject. Historians can rely on written records, and so might be thought to be on firmer ground than those trying to infer what human culture and cognition were like from non-verbal physical artifacts. Historians, however, often do not use strong inference, but look for documentation that is consistent with a particular interpretation of history. However, as demonstrated in this volume, cognitive archaeologists can use strong inference to construct solid evidence for theories of human cognitive and social evolution.

Sociobiology got into scientific trouble for telling just-so stories because it focused on behavior rather than on the mind (and into political trouble for those stories’ often having overtones of racism, classism, or sexism). Behavior per se cannot be acted on by evolution; only the brains and bodies that produce behavior can evolve by natural selection (Cosmides & Tooby, 1987). Sociobiology emerged at a time when psychology itself was mired in behaviorism, and thus a robust scientific

study of the *mind* had not yet emerged. With the cognitive revolution and the emergence of cognitive and social neuroscience, the information-processing structure of the human mind could be submitted to evolutionary approaches. These methods also allowed an escape from unsavory “isms”:

adaptationist approaches offer the explanation for why the psychic unity of humankind is genuine and not just an ideological fiction . . . why the differences among humans that are caused by genetic variability . . . are so overwhelmingly peripheralized into . . . functionally superficial properties.

(Tooby & Cosmides, 1992, p. 79)

Any evolutionary approach to studying humans, as cognitive archaeology emphasizes, must be a science of *all* of humanity, present and past.

Evolutionary psychology advocated using computational theories to develop evolutionary theories of cognition (Cosmides & Tooby, 1987). Such an approach is a multi-step enterprise:

- 1 *(Adaptive functional analysis)* Specify the adaptive function of the computation; that is, what is it that having this mental ability allows us to do?
- 2 *(Temporal analysis)* Identify the time period during which that adaptive problem existed.
- 3 *(Natural selection analysis)* Identify the relevant selection pressures that prevailed during that time.
- 4 *(Computational theory)* Propose a set of processes and representations that could serve the identified function. These must be powerful enough to solve the problem.
- 5 *(Operationalization)* Make predictions about patterns of behavior the proposed computations would generate.
- 6 *(Strong inference)* Devise tests between alternative theories that could explain the same pattern and one's own computational theory.

The chapters in this volume use one or more of these steps to explore the history and evolution of human mind and culture. Each one can serve as a point of departure for future inquiry. Cognitive archaeology is not just just-so stories, but a burgeoning interdisciplinary field of science.

Furthermore, cognitive archaeology brings the much-needed hard evidence of the archaeological record into the study of evolution of mind (Stone, 2002). Evolutionary psychology, in its earliest version, often claimed that the context for human evolution was that of Pleistocene hunter-gatherers, the lifestyles of our ancestors from roughly two million to ten thousand years ago (Buss, 1999; Cosmides, 1989; Cosmides & Tooby, 1987, 1992; Ellis, 1992; Kurzban, Tooby, & Cosmides, 2001; Silverman et al., 2000). It relied heavily on biological anthropologists' accounts of how contemporary hunter-gatherer or hunter-horticulturalist cultures live. This approach, however, assumes that contemporary hunting cultures are largely

unchanged from humans' ancient past. Such assumptions could be misinterpreted as the outdated practice of calling these cultures "primitive," with the attendant "we civilized people are better than you" attitude decried by Narvaez (this volume). Watkins (this volume), in his historical review, points out that cultures are dynamic. Although some features that relate to the physical environment may remain relatively constant, large changes in social organization, technology, and symbolic life can take place quickly. Hunting cultures must themselves have changed a great deal over time, particularly in response to colonization by non-indigenous peoples (Brody, 2000; Mann, 2005). The most remote cultures, with minimal contact with the industrialized world, are living in ecological regions to which they may have been pushed as other cultures grew and spread, and their cultural practices would likely have changed as a result. Thus, studies of contemporary hunting cultures, while valuable and necessary, cannot tell the whole story of our past.

Fortunately, our ancestors have left us clues. Clues to physiology and development can be found in their bones, endocasts, and teeth. Clues to culture and cognition can be found in their tools and art. Clues to evolutionary change can be found in genes. Cognitive archaeology uses those clues, with theories and findings of contemporary psychology, to build up a picture of how human cognition evolved over time to arrive at modern *Homo sapiens sapiens*. Not all aspects of our ancestors' lives leave durable records, of course, as Watkins (this volume) points out in his Foreword. Thus, neuroscience, genetics, comparative psychology, cross-cultural psychology, and anthropology are also key fields that contribute to this new approach to human evolution.

Psychology – and for many years, even evolutionary psychology – developed its theories largely without reference to the fossil record (Stone, 2002; Wynn & Coolidge, this volume). Claims about gender differences in aggression, for example, could be made as if they were simple statements of biologically based differences between the sexes based on differences in men's and women's sizes. However, sexual dimorphism is something that has evolved and changed in the hominin line (Oxford & Geary, this volume). Gender differences are also not the same between two groups of our closest primate relatives, bonobos (*Pan paniscus*) and common chimpanzees (*Pan troglodytes*; de Waal, 2001). Similarly, theories of child and adolescent development must take into account that extended development was something particularly selected for in the hominin line, and thus relatively recent, particularly adolescence and old age (Stone, 2007). Thus, the methods and techniques of cognitive archaeology can also prevent psychologists from telling just-so stories, by constraining psychological theories.

The chapters in this volume represent a range of topics within cognitive archaeology, and a range of approaches to the field. Wynn and Coolidge (this volume) present an integration of work in sports psychology, expert cognition, neuroscience, and the archaeological record of human technology to propose candidate cognitive abilities necessary for certain technological innovations to occur, a truly computational approach. Relying on those artifacts that can most easily be preserved over time is only a beginning, of course. The study of human technologies that involve

plants (ropes, nets, carrying vessels, and pharmacology) would not be as evident in the archaeological record (although Hagen & Tushingham, this volume, have provided some consideration of such issues). Nevertheless, the cognitive abilities that Wynn and Coolidge highlight could be applied beyond lithic technology, and using analyses of expert cognition, memory, and frontal executive functioning for plant- and landscape-based technologies might be enlightening.

Twomey (this volume) and Humphrey (this volume) provide historical-type analyses of fire and suicide, respectively. Twomey looks for evidence consistent with the idea that emotion regulation and social structures to avoid the freerider problem could have been prerequisites to controlled use of fire. While cheater-detection could be a human universal that avoids just this problem (Sugiyama, Tooby, & Cosmides, 2002), punishing of unfairness is highly variable across cultures (Henrich, Heine, & Norenzayan, 2010), making the problem Twomey has identified an important one for further research. Humphrey (this volume) speculates that suicide is a consequence of the fact that hominin evolution brought together mental time travel, theory of mind, and a desire to avoid suffering. Suicide was not itself, then, a target of natural selection, but an unfortunate consequence of mental abilities selected for other functions. An interesting way to test his ideas against alternative theories might be to compare suicide in remote hunting cultures that have little influence from industrialized cultures with those in agricultural and industrialized cultures. Such comparisons can illuminate the effects of social conditions on suicide (Tatz, 2001). Future work testing Twomey's and Humphrey's ideas against alternative hypotheses would bring them into line with strong inference.

Oxford and Geary (this volume) and Krause and Sanz (this volume) provide elegant examples of strong inference. The archaeological records of growth in skulls, bones, and teeth can be used to find evidence consistent with certain accounts of life history development and inconsistent with alternate accounts (Oxford & Geary, this volume). Krause and Sanz state the value of strong inference explicitly: "A truly evolutionary perspective of learning and memory processes needs a critical view that tests, rather than speculates, on their specific adaptive benefits" (this volume). They emphasize the importance of including comparative psychology within the scope of cognitive archaeology, so that claims that certain abilities are unique to humans can be tested against evidence.

Some of the limitations of contemporary psychology make clear that cross-cultural psychology will also need to be included. In cognitive archaeology, theories and findings from psychology inform discussions about the design features (e.g., expanded working memory) necessary for certain behavioral or technological changes. However, contemporary psychology is far from being the psychology of *humans*, as both Narvaez (this volume) and Henrich et al. (2010) have pointed out.¹ By and large, it is the psychology of undergraduates in industrialized nations. Psychological theories are derived from research primarily involving easy-to-find research participants: educated, relatively wealthy, young participants in nations with European-derived cultures and economies. Even research with participants from minority subcultures within those cultures is rare, as is research on other

cultures, including indigenous groups (Guthrie, 1998; Henrich et al., 2010; Narvaez, this volume).

Where psychologists have looked beyond industrialized or European-derived cultures, there is both unity and diversity in the human mind. Recognizing and producing certain basic emotional expressions, being able to tell who might potentially cheat in a social exchange, analog numeracy, inferring others' beliefs, and attachment styles all have some evidence of universality (Henrich et al., 2010; Schmitt et al., 2004; Sugiyama et al., 2002; van Ijzendoorn & Sagi, 1999). On the other hand, people from European-derived cultures can differ significantly from (and sometimes have poorer performance than) people from other cultures in several areas: tendency to punish unfairness, categorizing biological kinds, framing effects in decision-making, spatial navigation, understanding of local ecology, and providing social support to the mentally ill (Henrich et al., 2010; Kimmerer, 2002; Narvaez, this volume; Vicary & Bishop, 2005; Wang, 1996; Watters, 2010).

Furthermore, there may be many cognitive and social skills that are key parts of the human psyche that simply have not been studied by contemporary psychology because they are not as central in European-derived cultures. Possible examples are memory and perceptual skills useful in reading natural landscapes, olfactory skills essential for plant pharmacology, planning skills needed for landscape management, and relational memory structures for tracking kinship and ecological networks (Armstrong, 1995; Brody, 1981, 2000; Halford, Wilson, & Phillips, 2010; Kimmerer, 2002; Pascoe, 2018). Until the field of psychology's research samples are more representative of humanity as a whole, cognitive archaeology will need to choose carefully the aspects of psychology on which to base its theories. Members of non-European-derived cultures could make huge contributions by proposing psychological theories that come from their strengths, ones European-derived psychologists might never propose. Alternative explanations to evolutionary accounts offered in psychology, such as "this mental process is the result of culture, not biology," can be subjected to the method of strong inference by testing hypotheses across a wide range of cultures. Cognitive archaeology's emphasis on *all* of humanity can thus be an important corrective for contemporary psychology.

Just as the future of humanity depends on cooperation between nations, the study of humanity depends on collaboration across academic disciplines. A full understanding of whom we are as a species can never be the work of just one university department or one cultural viewpoint. The field of cognitive archaeology and the chapters in this volume represent the much-needed enterprise of cross-disciplinary work to investigate how we became what we are. By illuminating all of humanity, past and present, cognitive archaeology can help us understand ourselves so that we can thrive into the future.

Note

- 1 Henrich et al. (2010) describe psychological findings as limited because they are based on samples that are Western, Educated, Industrialized, Rich, and Democratic – WEIRD.

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Shipton

Figure 9.2

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Figure 10.1

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Figure 10.4

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Figure 10.5

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Hodgson

Figure 13.3

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Figure 13.5

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Wynn and Coolidge

Figure 14.1

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Acknowledgements

Figure 14.2

Image modified by authors based on Anne Delagnes, & H  l  ne Roche, Late Pliocene hominid knapping skills: The case of Lokalalei 2C, West Turkana, Kenya *Journal of Human Evolution* 48(5), 435  472; Fig. 8, May 2005.

Whitley

Figure 24.3

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Figure 25.1

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Humphrey

Figure 26.1

The Crucifixion of Christ. Late Roman, AD 420–30. Copyright The Trustees of the British Museum. Used with permission.

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PART I

Prehistory from the
perspective of physiological
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1

INTRODUCTION

What would Wundt think?

Edward P. Kardas and Tracy B. Henley

[T]he psychological historian is a prophet with his eyes turned towards the past. He ought not only to be able to tell what has happened, but also what necessarily must have happened, according to the position of events.

(Wundt, 1912/1973, p. 167)

Jacques Cauvin (2002, p. 236) defined cognitive archaeology simply as “reconstructing prehistoric ‘cognition,’” and as such, connected it with the domain of psychology. Psychology, in turn, is defined as the study of mind and behavior, and since the late 1800s that has primarily manifested as the empirical consideration of live subjects used in experiments, correlational studies, interviews, and observations. Most contemporary psychological work traces its roots to Wilhelm Wundt’s laboratory-based model, what is sometimes termed as his *first psychology* (e.g., Henley, 2018a; Kardas, 2014). Based largely upon this methodology, psychology has generally not been connected with the questions of prehistory. One can find isolated considerations, such as Rollo May’s (1991) work on myth, but a clear, temporal division of labor with respect to the study of human nature seems to suit modern psychology. That is, the study of social behavior among college sophomores is absolutely a psychological topic, but considerations of the daily life of Incan priests, Ming dynasty philosophers, Sumerian scribes, or Neolithic hunter-gatherers is the province of historians and anthropologists.

Evolutionary psychology stands as something of an anomaly to this picture. It potentially offers a grand theory for psychology grounded in our evolutionary history as a way of explaining the behaviors of college sophomores as well as Sumerian scribes. But, even if we stipulate that evolutionary psychology is “on the rise” (due in no small part to popular works by Pinker [1997] and others), many psychologists see it as not immediately relevant. That is, the majority of empirical work done in clinical, cognitive, developmental, educational, physiological, or social psychology,

just to name a few subfields, is not done from an evolutionary perspective and usually makes no attempt to align itself toward that grand theory. Instead, psychologists remain interested in matters such as treating schizophrenics, understanding the structure of memory and cognition, measuring intelligence, teaching middle-schoolers how to learn math word problems, identifying the parts of the brain activated by violent images, and understanding the role of cell phones in the dating relationships of college students. Although each of those *could* be connected to evolutionary psychology, typically they are not.

We will revisit the place of evolutionary psychology again shortly, but for now, we ask, “What would Wundt think about all that?” In the context of writing about Wundt’s later interest in matters social and historical, his *second psychology*, as it is often termed, Cole (1996, p. 98) opines:

Were Wilhelm Wundt alive today to assess the attempt to use the methods of experimental/quantitative psychology to found a culture-inclusive psychology, he would certainly have the right to declare “I told you so.” After all, it was Wundt who . . . pointed out that individual human psychological processes are conditioned by an earlier history of the community to which they have no direct access. And it was Wundt who asserted that genetic (historical, developmental) methods are needed to deal with culturally mediated, historically contingent, “higher” psychological processes.

Both of this chapter’s authors are primarily historians of psychology (so, second psychologists, if you will). This makes us suspect in the eyes of many of our experimentally oriented, first psychology peers. When students or colleagues ask us what current project we are working on, our latest answer, “prehistoric psychology,” usually brings out grins of bemusement. When they see we are sincere and after we begin to explain that what we are really looking at is human thought and behavior from 10,000 years ago and beyond, we often get a glint of interest and a desire to learn more – especially among those first psychologists with an evolutionary approach to our discipline.

For one of us (EPK), interest in the human past began when he was 6 years old after reading *Life* magazine’s (1955–7) six-part series “The Epic of Man.” Since, he has often wondered how humans initially discovered fire, learned to knap flint, or developed societies. In his history of psychology textbook (Kardas, 2014), wanting to leave no historical stone unturned, he included a chapter titled “From Prehistory to Civilization” that covered well over a million years of hominid history and used Sagan’s (1977) calendar analogy to illustrate the incredibly short proportion of time that behaviorally modern humans have lived on earth. It discussed toolmaking, language, and sociality as primary human universals. It traced the evolution of humans from hunter-gathering to the rise of “modern civilizations” such as Sumer, Egypt, and Greece, where the first rumblings of psychology are usually traced. Along the way that chapter touched on Mithen’s (1996) Stone Age thinking categories: natural history and technical and social intelligences; as well as aspects of the Neolithic

Revolution such as sedentism (Holmes, 2004); domestication (Diamond, 1997); urbanization (Mumford, 1956); and the invention of “modern” religion and philosophy (Russell, 1927), all topics that are not a major part of psychological research (first or second) today.

The other of us (TBH) coincidentally can also trace his interests in archaeology back to readings from age 6, but much later came to be aware of the newest “cognitive revolution” in academia (e.g., Kuhn, 1996), the one impacting archaeology. Following Cauvin (1994/2000), Schmidt (2010), Watkins (2017), and others was the assertion that the Neolithic Revolution was not caused by sedentism, domestication, and urbanization, but that those were the byproducts of a more fundamental change in our cognitive and social psychology. The rise of civilization then was as much a question for the historian of psychology as the anthropologist and archaeologist (Henley, 2018b).

This volume began then with TBH reaching out to the other two editors for a symposium on prehistoric psychology at the Southwestern Psychological Association. It was there that EPK explicitly connected the juxtaposition of evolutionary psychology and cognitive archaeology with Wundt’s *Völkerpsychologie* and first asked what would Wundt think about modern scientists exploring the minds and behaviors of those who lived from 10,000 to 2+ million years before present (ybp).

Wundt’s two psychologies

Wilhelm Wundt, Leipzig, and the year 1879 are accepted by virtually all psychologists as the person, place, and date involved in the founding of our discipline as an experimental science. That said, from his earliest writings Wundt expressed his belief that experimental methods would be insufficient for addressing certain matters. As Cahan and White observe (1992, p. 227):

Wundt saw his second psychology as an essential complement to his experimental psychology and this vision would ultimately lead him, in the early 1900s, to the writing of a 10-volume survey of ethnographic data about the language, myth, and customs of diverse human cultures.

Wundt believed all of psychology was obligated to appreciate and explore the developmental and social processes that led to the creation of individual consciousness. As such, Wundt saw psychology as a discipline consisting of two parts. One part, *first psychology*, for which he remains revered, was lab-centered and used scientific methods to study presumably universal human characteristics such as sensation, perception, and physiological psychology. The other part, *second psychology*, culminates with his *Völkerpsychologie*, a term he inherited from Moritz Lazarus and Heymann Steinthal (Cahan & White, 1992), and in the tradition of Johann Gottfried Herder and Wilhelm von Humboldt it would be a science addressing the character of peoples (Greenwood, 1999). As time passed psychology seized upon Wundt’s experimental approach and its laboratory methods, and all but ignored his *Völkerpsychologie*.

Second psychology after Wundt

Both Blumenthal (1975, 1979, 1998) and Danzinger (1980) document the adoption of Wundt's first psychology, and the neglect of his second, in the United States. Central to that story, Watson (1913, p. 163) famously sought to make psychology into "an undisputed natural science." In other words, convert all psychology into first psychology. As a comparative psychologist he had experienced success in using animals in his research. He argued (p. 176), "The position is taken here that the behavior of man and the behavior of animals must be considered on the same plane; as being equally essential to a general understanding of behavior. It can dispense with consciousness in a psychological sense." Watson's position gradually gained acceptance, and in turn dominated American psychology for several decades.

By the 1930s then, a first psychology of behavior (not consciousness, as Wundt had sought) was in fashion. As Cahan and White (1992, p. 231) write, "Behavior theory, experimental psychology, and inferential statistics were brought together to form a new image of scientific psychology." First psychology was firmly entrenched in US universities, although elements of second psychology lingered, as evidenced by early forays into social psychology (e.g., Allport) and psycholinguistics (e.g., Ogden), as well as the eventual creation of nontraditional "outsider" programs such as Harvard's Center for Cognitive Studies or Yale's Institute of Human Relations. Still, by the time of psychology's "cognitive revolution" in the late 1950s and early 1960s, it was too late for second psychology to assert itself successfully back into academic psychology departments in any autonomous form. Cahan and White (p. 233) claim that "second psychology tried to materialize within the disciplinary structure of universities but the allied disciplines were already too highly structured."

That said, many of the topics of Wundt's second psychology (e.g., art, ethics, language, law, or religion) are all present in contemporary psychology, but as politely implied in our opening they often demonstrably stand as "second class" to first psychology (and to funding agencies' favorites such as cognitive neuroscience). In most US psychology departments resources and prestige still align with the scientists whose work is nearest to physiology, and not the people down the hall who publish second psychology works on art, education, ethics, history, or religion.

Interestingly, another search for how to reconcile Wundt's two psychologies took place in Russia at about the same time that Watson birthed American behaviorism. There, the likes of Bechterev, Pavlov, and Sechenov had also established an objective and behavioral first psychology. With interests at the psychological interface of art, culture, education, as well as what we would now call social cognition, Lev Vygotsky (e.g., 1930–1934/1978) additionally wrote about psychology's own identity (Dafermos, 2014). Similar to Wundt's erstwhile student Hugo Münsterberg, Vygotsky understood psychology as divided into two parts: a naturalistic-scientific explanatory one (what Münsterberg deemed "causal psychology") and a philosophical-phenomenological descriptive one (what Münsterberg deemed "purposive psychology"). Vygotsky shared Wundt's ultimate goal for a unified psychology of higher mental processes (though his death at age 37 put an untimely end to that effort). Hyman (2012, pp. 480–481) notes, "Vygotsky astutely observed that

psychology in his time faced the challenge of reconciling the . . . individual and [the] social . . . This challenge is still with us.”

Evolutionary psychology as a unifying force

Since its cognitive revolution some 50+ years ago, first psychology itself has had three clear strands: behavioral, biological, and cognitive, which at times have been fiercely competitive. Staats (1991, p. 899) observed that the “result is a great and increasing diversity – many unrelated methods, findings, problems, theoretical languages, schismatic issues, and philosophical positions.” In turn, meta-theorists with an interest in describing the discipline itself, such as Sternberg (2005), have argued that it is time for psychologists to seek unification by considering phenomena from various viewpoints, setting aside narrow theoretical formulations, and measuring phenomena using multiple methods.

Although being historians requires us to note that Angell (1907) was likely the first to make the suggestion, more recently Ploeger, van der Maas, and Raijmakers (2008; see also the reply by Duntley & Buss, 2008) are among those who offer up evolutionary psychology as a possible unifier of psychology. This idea has outspoken proponents (e.g., Buss, 1995), but Ploeger remains dubious unless the scope of evolutionary psychology itself expands. As we noted previously, the misalignment she points to actually cuts both ways. That is, it is not just that evolutionary psychology may be too narrow for the totality of psychology, but also that many contemporary psychologists focused on solving immediate problems in the clinic or classroom see no benefit from embracing an evolutionary perspective.

Wundt himself was also somewhat dubious about the alignment of evolution and psychology. In his *Lectures on Human and Animal Psychology* (Wundt, 1894), Wundt asserts that Darwin has undervalued the psychology – the active minds – of animals in shaping their own fate. That is, animal evolution was not a passive and one-directional process of environmental influence, but also included how perceptive and cognitive creatures themselves responded to their environments (for more on Wundt and Darwin, see Richards, 1980).

Although most of the psychologists in this volume would self-identify as “evolutionary psychologists” the enterprise is, perhaps ironically, also not squarely juxtaposed with either cognitive archaeology or psychological prehistory. To paraphrase one reviewer of this book’s initial prospectus “there is no such thing as psychological prehistory; it is all just evolutionary psychology”; and when asked to join this volume another prominent scholar in evolutionary psychology declined on grounds that neither the history of psychology nor cognitive archaeology overlapped with his (first psychology) approach.

So, what would Wundt think?

It seems likely that Wundt would have endorsed both evolutionary psychology and cognitive archaeology, and perhaps would have believed that when triangulating between the two of them some important truths about human nature could be

revealed. For Wundt the utility of a cognitive archaeology would not have been in discovering the specifics of any ancient people's beliefs or lifestyle (as important and as fascinating as those may be), but in revealing by their comparative study the general psychological laws that must obtain for such beliefs and lifestyles to be realized. At the risk of over-reaching, we can imagine that for Wundt the ideal conclusion of the *Völkerpsychologie* would have read something like Brown's (1991) list of human universals.

Wundt's second psychology required close examination of individuals within their social context, something he knew that his experimental methods were not optimally suited to. Cole's *Cultural Psychology: The Once and Future Discipline* (1996) aimed to re-ignite the embers of a long smoldering second psychology. Greenwood (1999), in his review of Cole's book, takes pains to illustrate that it is hard to cross the line from first to second psychology. No doubt it is even harder to cross that line when the subjects of study have been dead for millennia and the only evidence they left behind consists of artifactual remains. Our aim then is that this volume can serve as another step toward an understanding of the exceedingly complex amalgam of individuals, genders, cultures, and even species that make us human. At the same time we propose to study our prehistory in such a way that it can still be called objective and found acceptable to entire communities of scholars from disparate disciplines.

Introduction and overview

As noted previously, evolutionary psychology is currently a hot topic within our field, and one that has even been lauded as potentially offering our discipline theoretical unification. Arguably, cognitive archaeology is hotter still. Both ventures are intrinsically interdisciplinary, and this volume has 38 different contributors who represent not only psychology and archaeology, but also anthropology, history, medicine, and philosophy. Interestingly, and purely by chance, the split between psychologists and non-psychologists is nearly 50-50.

The book opened with twin Forewords, one from the perspective of cognitive archaeology (Watkins) and the other by a psychologist (Stone). Following that, we have organized the chapters into four topical sections:

- Prehistory from the perspective of physiological and developmental psychology
- Prehistory from the perspective of cognitive psychology
- Prehistory from the perspective of social psychology
- Prehistory from the perspective of personality and clinical psychology

Of course, many of the chapters could have been placed otherwise – that is, they cross over into matters such as physiology and cognition, or development and sociality. That said, in the rest of this initial section we directly examine **Prehistory from the perspective of physiological and developmental psychology**. The progression moves generally from more biology-near topics to matters of human development writ large.

This begins with **Konner** exploring several matters linking psychology and cognitive archaeology via his research on recent hunter-gatherers (RHGs) including: diet, the evolution of childhood, childcare, and comparative evolutionary brain development. Comparing the diets of RHGs against the archaeological record helps generate hypotheses about early hominins and their nutritional physiology. The comparative analysis of the evolution of childhood may explain the increase in brain size, bipedal walking, and altriciality in *Homo sapiens*. Konner reviews work with RHG groups throughout the world, specifically focusing on mother primacy, parental care, alloparenting, and care by children. He concludes that while results from archaeological excavations will always retain their importance in examining prehistory, evolutionary theory along with data from physiological and developmental psychology offers new and exciting ways to interpret the past.

Providing a foundational overview, **Oxford and Geary** discuss life history theory and examine species-specific variables such as the time and energy relationships between mortality, fertility, growth, and the tradeoffs in somatic vs. reproductive effort. Those yield a continuum: *Live fast die young; live slow die old*. Primates exhibit slow growth, delayed reproduction, fewer offspring, increased learning ability, and higher levels of sociality. Australopiths were small-brained, highly sexually dimorphic, and polygynous. *Homo erectus* were larger brained and bodied, more adept tool users, less dimorphic, carnivorous, and more social, but had no adolescent growth spurt. Neanderthals' brains were large but structurally archaic. Indeed, their rapid brain development may have rendered them less socially adept. Behaviorally modern humans are at the extreme of the continuum and possess unique features including secondary altriciality, childhood, menopause, and grandparenting.

Habecker and Flinn, the first of several coauthor teams spanning psychology and anthropology, also discuss the evolution of human family relationships, focusing on their hormonal substrates. Humans have intense maternal care but uniquely exhibit stable breeding bonds, extensive paternal care, lengthy childhood, bilateral kin recognition, grandparenting, brain size expansion, lengthened gestation, shorter interbirth intervals, prolonged development, and delay of reproduction. Together, those must have conferred fitness benefits including the creation of more complex communities via intergroup cooperation and competition with other patrilocal bands and tribes. They review the extensive hormonal literature for bases of attachment, family love, and paternal care. They conclude that evolutionary biologists, psychologists, anthropologists, and archaeologists must understand how "general neuroendocrine systems have been modified and linked with other special human cognitive systems."

Krebs analyzes moral development from the viewpoint of evolutionary theory. He reviews psychological accounts of moral thinking and behavior, arguing that they do not fully explain the adaptive nature of morality. Evolutionary theory balances individual selfishness with our species' inherent and adaptive need for cooperation. Theories of morality must answer questions of survival and reproduction while also accommodating genetic and physiological factors. Older brain structures evolved for small group living and operate when we are stressed or cognitively taxed,

whereas newer human structures may account for the differences between moral thinking and moral acting. Newer structures may also resolve conflicts of interest and persuade others to act morally (meaning to uphold biologically evolved beneficial cooperative systems). Yet as Krebs observes, we evolved those newer, rational, moral decision-making capacities because we are the only species that needs them.

Taking a much broader view, **Narvaez** urges psychology to escape its fore-shortened fishbowl view of itself by adopting a longer baseline similar to cognitive archaeology's six million years. Psychology's dominant approach comes from of a negative view of human nature and prehistory, with biases toward literacy, individualism, and abstraction. She uses the "evolved nest," a set of characteristics optimized to provide normal development of the young as analogy. In hunter-gatherers, with groups extant for over 150,000 years, it leads to healthy outcomes, cooperative personalities, and buffers against genetic variation. She wonders whether assumptions about civilization humanizing people are correct – with the data on health impairments wrought by civilization, the newfound dominance of the left side of the brain, and the primacy of language arguing against it. In sum, using cognitive archaeology to extend psychological science's timeline backwards would result in a more sustainable lifestyle and more positive view of human nature.

The story of snake handler Jamie Coots bookends **Burghardt's** analysis of play in animals and humans. Fatally bitten, Coots refused medical attention and died. He played a risky game and accepted the results. Burghardt's thesis is that play, ritual, and religion form a continuum. He proposes Surplus Resource Theory to argue that play occurs when animals and people have extra energy, time, and resources. Play in animals and humans is incompletely functional, spontaneous, different, repeated, and initiated in the absence of stress. Human play adds pretend, sociodramatic, humorous, rule-based, and mental activities. Play teaches us values such as cooperation, fairness, and morality while reducing xenophobia and intergroup aggression. Illustrating how play can lead to ritual and religion also serves as an excellent segue into the topic of cognition.

Arranged roughly from broader to narrower topics (and roughly chronologically), the second section – **Prehistory from the perspective of cognitive psychology** – begins with **Corballis'** proposing that generativity is not an exclusively human linguistic phenomenon, but a characteristic of thought. Data suggest the hippocampus and other structures including the entorhinal cortex provide *both* rats and humans with a grid-like map (likely evolved to navigate the environment) as well as the capacity for mental time travel. In turn, this suggests that generativity is a product of movement, and that internal representations of time and space "are at the heart of mental function." Throughout, he considers the possible origins of our generative language, examining such touchstones as theory of mind, polysemy, conventionalization, ostensive-inferential understanding, pointing, mimesis, and sound generating motoric movements. He concludes that generativity originates in bodily gesture and that language emerged for sharing mental travels because cooperation required it.

Covering some of the same topics, **Shipton** argues for a gradualist view of how human thinking has changed over the last million years: Normativity, recursion, and

abstraction merged slowly and fitfully. Latent overimitation led to normativity in both behavior and technology. Recursion, the ability to disembed and use feedback loops, followed, evidenced by the use of new landscapes and obvious forethought in flint knapping. Abstraction, from thinking of intangible objects and mental time travel to counterfactual situations, again followed. Artistic designs, burials, grave goods, and ordinal thinking provide evidence of abstraction as do long-distance exchange networks, tribal identification, notched bones, bows and arrows, and standardized miniature stone tools. By 70,000 ybp supertribal groups existed, technologies were exchanged, and *Homo sapiens*' range had expanded to nearly all the world.

Krause and Sanz also consider the role of mental time travel as they probe the adaptiveness of both learning and memory. For them, mental time travel is a flexible component of episodic memory that allows for anticipating the future. In humans, episodic memory has been reliably demonstrated in children as young as age 4. Chimps taught American Sign Language have also demonstrated episodic memory and time travel ability. But, in carefully controlled lab experiments, so have non-verbal animals such as scrub jays, rats, and pigeons (and field studies have provided similar results). As such, Krause (a psychologist) and Sanz (an anthropologist) recommend that jointly psychologists and cognitive archaeologists should come together using all manner of possible approaches including fossils, genetics, and comparative studies for the ultimate goal of better understanding the adaptive nature of learning and memory over evolution's long course.

Like Krause and Sanz, **Fabrega** takes a comparative approach to the "deep archaeology of cognition." Specifically, he expands and reformulates Natural Semantic Metalanguage, a system of study designed to compare the meanings of concepts among diverse human language speakers, to introduce a potential methodology for considering the minds and behaviors of evolutionary creatures that preceded *Homo sapiens*. His chapter also reviews many of the issues related to any understanding of cross-species behavior from a mentalistic perspective.

Another psychology-anthropology team, **Gabora and Smith**, focuses on two particular psychological transitions seen in the archaeological data. One in *Homo erectus* (2.8 to 0.3 million ybp) and the other in later *Homo* (100,000 ybp) that together led to the emergence of behavioral modernity. These changes were gradual, but ultimately differentiated modern humans from other primates. They argue that a larger brain and finer-grained memory powered the first transition enabling self-triggered recursive recall, streams of abstract thought, and increased cognitive ability. The second transition originally appeared in Africa and then later in Europe as shown by evidence of novel tools, burials, personal ornamentation, cave art, religion, and increased caloric intake. Specifically, these factors manifested as a new ability to control shifts between associative and focused thought – a cognitive fluidity that is a uniquely human phenomenon. Exaptation, the co-opting of existing traits for new functions, and also genetic mutations (i.e., the FOXP2 gene, broadly) likely played a role in such transitions.

Narrowing the focus even further, **Hodgson's** chapter proposes that many factors – intrinsic, neural, and social – are needed to fully explain the evolution of

the handaxe's form from simple functional tool to valued and aesthetic object. He argues that other aesthetic markings (e.g., repetitive patterns, zigzag motifs, and use of colored pigments) derive from the same developmental pattern. He provides evidence that the creation of handaxes and marked objects is more ancient than previously believed. Few early handaxes were aesthetic, but later ones were more symmetrical and functional. As knappers became more skilled they gained automaticity leaving them surplus cognitive capacity and time to create more symmetrical and aesthetic tools, which, in turn, were highly valued by society. Hodgson provides a complex neurological model explaining how and why the aesthetics of handaxe production changed and led to the creation of other made, and marked, objects.

In the final chapter of this section **Wynn and Coolidge** examine technical cognition, an underappreciated facet of expert cognition. Modern blacksmithing is a model because of its mostly nonverbal craft-like expertise, apprenticeships, requisite long-term memory, as well as the intimate knowledge of materials and tools necessary for success. Nut cracking by chimpanzees using stone tools (anvils and hammers) is technical expertise too, but involves emulation not imitation. Comparing chimpanzee tool use to that of human flint knappers at Lokalelei2C (2.3 million ybp) they conclude that the difference in cross-species expertise is quantitative and knappers did imitate each other. At the Gesher Benot Ya'aqov site (780,000 ybp) knappers used several techniques and created different types of tools, some obviously fashioned beyond the need of functionality (made for social reasons). Additionally, the processes were temporally discontinuous. The objects created in all cases just noted depended on memory, cognitive control, and culturally passed-on knowledge; but they did not require language, the authors contend.

And it is language that we next consider to start the third section – **Prehistory from the perspective of social psychology**. The first chapter here is an update of a previously published article by **Donald** that approaches the evolution of language as a phenomenon whose generativity comes from the demands of the social environment. For Donald, language could not have originated prior to the development of refined skills, cumulative memory, and social living. Mimesis, metacognition, and self-supervision appear in the fossil record starting with *Homo erectus* as seen by tool-making, fire tending, and cooking – innovations that created selective advantages for social groups but required pedagogy for their continuance. Vocal skills, too, conferred selective advantage and coevolved along with voluntary access to procedural memory, better metacognitive self-supervision, and brain-based developmental plasticity. Full language (e.g., an original narrative based on personal experience) emerged much later (one million ybp), while innovations such as analysis and mathematics came only very recently. By this account, language evolved in a social context, and is ultimately a matter of social psychology.

The rest of this section explores matters that address social rituals and norms, and as the section unfolds sexuality becomes a more central topic of these considerations. To start, **Nielsen** argues that social overimitation, a deep-seated feature of human behavior, is at the core of both ritual and science. Modern research shows how children precisely imitate adult models, especially when they include irrelevant steps

in a procedure. In the Acheulean few new tools are found, and variants yielded no additional functionality (e.g., showing overimitation). In the Palaeolithic new tools appeared along with features of ritual: pigments, abstract markings, and personal ornamentation, evidence of cumulative culture. For Nielsen, overimitation is the basis for ritual, and by extension, for religion. This same overimitation is also the basis for science's precise processes and its cumulative culture (the accumulation of data). Independently evolved social support systems ("coupled with state-subsidized health care systems") might come to replace religion, but science will not; it cannot, because both share the same cognitive framework.

Dietrich, Notroff, Walter, and Dietrich also consider matters of technological innovation and religious ritual, but in the context of the mysteries surrounding the Neolithic monumental architecture of Göbekli Tepe. What came first, cognitive change (e.g., artwork, symbols, "religion") or the technological developments of sedentism (buildings, the domestication of crops and animals)? The special purpose buildings found on site are of particular interest as they are furnished with benches, rich decorations, sculptures, and large megaliths decorated with images of dangerous animals. Today, those monumental structures suggest purposeful abandonment, backfilling, and the intentional deposition of broken sculpture fragments (especially heads). Evidence of meat feasting exists, and the provisioning of meat along with the construction of the special purpose buildings may indicate costly signals by upper class members to the emerging community. Also, the site may be evidence of a new type of "doctrinal" ritual better adapted to complex and hierarchical societies than the "imagistic" rituals of hunter-gatherers.

In keeping with ideas previously introduced, **Rossano** focuses on costly ritual as a mechanism whereby *Homo sapiens* was able to develop highly cooperative and tribally minded communities. Ritualized behaviors and ritual itself differ. The former is found in animals and humans: mating dances in waterfowl and the proscribed movements of believers in a mosque. Canonical ritualized behaviors are larger (the state of mind of bride and groom – love and a lasting commitment, or the voluntary submission to a higher supernatural being). Traditional societies' ritual behaviors include movements and bonding, and create shared emotional states. Costly rituals, such as initiations (which may involve intense pain, cutting, or scarification – and usually under social scrutiny), eliminate freeloading and lead to intense levels of commitment to the group. Rossano considers differences found in ocher collection, beads, dangerous cave use, and burials to suggest that *Homo sapiens* displaced Neanderthals through the effects of costly rituals that created highly cohesive groups and provided the health benefits conferred by supernatural beliefs.

Power examines the interrelationships of language, ritual, reduced social dominance, and egalitarianism in human history. Female cosmetic coalitions arose against alpha male cultural dominance through a reverse Machiavellian strategy involving the use of ocher pigments: Alpha males could no longer easily identify menstruating females. Those coalitions created symbolic and well-understood messages related to egalitarian access to reproduction, leading to a deep social mind, a convergence of egalitarianism, culture, and linguistic mind-reading. Matrilocal allocate by

grandmothers and other blood relatives allowed for increased reproductive potential by fecund females and greater egalitarian male reproductive opportunity. Slowly, language and ritual (e.g., human symbolic cognition systems) emerged – the former a low-cost tool for increasing individual mutual understanding and the latter a high-cost mechanism for generating and maintaining group identity.

Sterelny considers the development of norms, specifically those that coevolved with erectine cooperation. Foraging groups initially transitioned from independent foraging to immediate return mutualism (1.8 to 800 million ybp). Later, indirect reciprocity became important (120,000 to 50,000 ybp). The next transition was to community-level collective action and cooperation (Late Pleistocene). The very end of the Pleistocene and the early Holocene saw cooperation among sedentary, complex, hierarchical societies. Problems in cooperation included reputation, social capital, fairness, and policing norm violations. Implicit and explicit norms aided in the maintenance of cooperation. Sex, too, was another area fraught with the potential for conflict. Issues of access to partners, paternal uncertainty, male investment, female choice, kin selection, and fidelity all came under a variety of norms. Gradually in the more complex social and economic environment of the Late Pleistocene, explicit norms were negotiated and observed.

The final chapter in this section then concerns sexuality specifically. **Taylor** takes a wide perspective, touching on numerous interesting issues that predate hominids as well as those intersecting with modern sexual culture. Although special attention is given to changes in dimorphism, much of the chapter stands as a meta-narrative about some of the methodological issues bound up with any attempt to explore a psychological topic as complex as sexuality within the context of prehistory.

The closing section concerns **Prehistory from the perspective of personality and clinical psychology**. The section transitions smoothly from the previous consideration of social psychological matters as it starts with emotional regulation, moving then to consider situations where such regulation fails. **Twomey** discusses the benefits of fire that became part of human experience between 1,000,000 and 330,000 ybp, including cooking (as cooked food is easier to chew, digest, and metabolize). Fire use progressed into long-term maintenance, and the “cooking hypothesis” can explain the vast increase in human brain size. Fire making is not, however, cognitively complex. Neanderthals used fire by 120,000 ybp, and contemporary research shows that chimpanzees can learn to light and not fear fire. As such, the common ancestor to Neanderthals and cognitively modern humans likely used fire. The emotional and social aspects of fire making and provisioning require forethought; it is a detached system. It also requires managing freeriders and bullies. As a public good, fire led to increased emotional regulation, a more complex human ecology, and the attainment of more remote goals.

Hayden argues that secret societies founded by sociopaths exerted outsized power and influence in many prehistoric cultures as they moved from simple to complex hunter-gathering. The creation of surpluses and sedentism led some personality types (e.g., sociopaths and aggrandizers) to manipulate others through the creation of secret societies. In turn, they promoted feasting and gifts as mechanisms

to win over nonmembers – claiming arcane knowledge and professing to use it to protect the group. In actuality, they emotionally exploited and intimidated others while securing wealth and power for themselves. Hayden provides many examples of secret societies from around the world in support of his thesis including Göbekli Tepe, Poverty Point, Chavin de Huantar, Chaco Great Houses, and Stonehenge.

Whitley also examines the archaeological record for evidence of psychopathology, looking especially at mood disorders in shamans. Shamanism is evident from 35,000+ ybp, and suggestive of hereditary illnesses, recurrent transitory episodes involving hallucinations, pain, social withdrawal, melancholia, antisociality, obnoxiousness, sexual promiscuity, and a propensity for suicide. Shamans created rock art masterpieces worldwide, famously in Western Europe, that included themes of animal/human conflation, grief, death, killing, combat, aggression, drowning, and sexual arousal. Their quality is evidence of artistic genius. Introgressive hybridization with Neanderthals may partly be responsible for the appearance of major depression and schizophrenia in cognitively modern humans. Additionally, the rigorous Upper Palaeolithic climate favored selection for bipolar disorder, a kind of adaptation for winter hibernation and summer mania.

Having moved from personality to psychopathology, **Hagen and Tushingham** review the prehistory of psychoactive drug use. Plants and animals have been engaged in an evolutionary arms race. Paradoxically, humans may have begun consuming plants for their toxic effect on parasites (especially worms), a kind of self-medication, with the psychoactive properties of nicotine and hallucinogens as another (similar) gateway. Cultural learning also played a major role in drug choice and use. Ethanol, seemingly, falls outside the plant toxin model. However, as a product of fermentation yeasts it conferred protection from other microbes. Primate use of ethanol may have resulted from the natural fermentation of fruit. Thanks to protective mutations, ethanol became an important part of hominin diets. Archaeological evidence reveals ancient tobacco use and shamanistic use of hallucinogens. Hominin use of drugs was worldwide and included coca leaves and cacao in the Americas, and teas and betel nuts in Asia. They conclude, “psychoactive substance use is simply not a modern phenomenon.”

Tackling what some would consider the greatest failure of emotional regulation, or expression of psychopathology, **Humphrey** ponders how suicide can maintain itself. In an update of a previously published article, he notes that moderns have labeled suicide as self-murder, criminalized it, and suffered its contagiousness. Altruistic suicides, those sacrifices made so others might live, can be adaptive in an inclusive fitness sense. But, egoistic suicides, which constitute the majority of those deaths, are not adaptive. Those are hardly ever contemplated but rather are quick solutions to perceived personal problems, devastating to others, and often performed for trivial reasons. Around 100,000 ybp ancient humans were blindsided by the realization that taking one's own life was possible; that is when cognitive skills such as “what if” reasoning, self-awareness, and theory of mind first made their appearance. Cultures that inculcate their members with fears of afterlife punishment act as a brake, as does sensory consciousness, and the joy that comes from “the magical qualities of sensation.”

Having introduced the topic of death from a psychological perspective, the final content chapter – also modified from a previous work – is **Pettitt**'s cognitive archaeological consideration of developments in mortuary and funerary behavior. Many animals remove dead conspecifics cued by chemical changes. Thus, humans share a deep evolutionary revulsion to their dead, blood, and the places of their deaths. Whether early humans thought about death symbolically remains an open question. Pettitt describes historical stages in the response to death over time. He proposes a reverse timeline: Modern views of death with specific locations (e.g., cemeteries) began about 15,000 ybp. In the Late Upper Palaeolithic rituals about death, including bodily fragmentation, existed. Social differentiations in burial (only some high-status people were buried) are found in the Mid Upper Palaeolithic. Commemorative relics of the dead possessed by the living are found in the Early Upper Palaeolithic. He asserts that the answer to the question "Did Neanderthals possess a symbolic capacity?" is "yes" based on such evidence.

The last chapter, by all the **editors**, offers an integrative summary and highlights several of the themes that recur throughout the entire book. Although edited volumes typically get digested selectively, it is the case that the 30 different writings collected here form a coherent narrative analogous to the structure of a comprehensive textbook. The conclusions drawn culminate with an affirmation that both psychology and cognitive archaeology will assuredly benefit from increased interplay.

Conclusion

A few final points . . . Even with 28 chapters (and two Forewords) this book is by no means comprehensive. It samples, not surveys, the spaces where psychology and cognitive archaeology intersect. That said, that disparate writers – often from different academic disciplines – frequently included similar topics (e.g., ritual) is perhaps diagnostic of areas inviting further attention. Related, by design the book spans from animals that predate the genus *Homo* to (as Cauvin, 1994/2000 wrote) "the birth of the gods and the origins of agriculture." In different ways both archaeology and evolutionary psychology have each investigated all this vast time range, and now cognitive archaeology offers the promise of fruitful future communion (see also Wynn, 2002, and replies).

The name the public most associates with psychology beyond Wundt is, of course, Sigmund Freud. The good doctor held a life-long reading interest in academic archaeology and famously kept his office decorated with finds. Discussions of his archaeological metaphor for psychoanalysis abound (e.g., Bowdler, 1996). To mirror the Wundt quote we opened with, we close then with a bit of Freud (1913/1990):

Prehistoric man, in the various stages of his development, is known to us through the . . . implements which he has left behind, through information about his art, his religion and his attitude towards life which has come to us . . . through the relics of his mode of thought.

(p. 53)

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2

BEFORE, AFTER, AND ALONGSIDE THE EXCAVATION

How to think about the evolution and
history of physiology and development

Melvin Konner

An enterprise such as cognitive archaeology – the focus of this volume and part of its title – must ultimately rely on excavations for the testing of all hypotheses and the formulation of many. This is even more true of the book’s subtitle, “Psychology in Prehistory,” since psychology is much broader than cognition. For example, violence, including organized violence, is a behavioral and psychological process that is not generally considered to be in the domain of cognition, but recent excavations have underscored its importance in prehistory (Jantzen et al., 2011; Lahr, Rivera, Power, Moonier, et al., 2016a; 2016b; Stojanowski, Seidel, Fulginiti, Johnson, & Buikstra, 2016), although controversy continues about whether it increased after the advent of agriculture (Ferguson, 2013; Lambert, 2002). The emotions involved in violence and war (hatred, anger, fear, etc.) are not generally considered cognitive, but they are certainly psychology and behavior.

If “prehistory” is taken, as it is by many of the volume’s contributors, to include pre-human prehistory, then the enterprise must include nonhuman primates at least. But since the laws of evolution are highly relevant to any attempt to make inferences about protohuman minds – or bodies for that matter – and how they changed to make us, the domain of interest could extend to all animals or even all living things. Recent research showing that plants cooperate with and favor their kin shows the applicability of kin-selection theory beyond the animal kingdom (Pennisi, 2019). Plants, as far as we know, do not have cognitive functions, but they have some way of responding to the general laws of evolution.

In this chapter I will try to elucidate principles relevant to the use of data from comparative and mechanistic biology that, in cooperation with direct archaeological data – the ultimate arbiter of all hypotheses, where the record is good enough – can help us to “retrodict” or reconstruct the human past to the best approximation possible. I will draw examples mainly from my own work and that of colleagues in my department, since I know it best, but I will also cite similar work by others.

“Palaeolithic” diet and lifestyle

A paradigmatic case for me is the so-called “Palaeo” diet, which Boyd Eaton and I presented an early version of (S Boyd Eaton & Melvin Konner, 1985), updated periodically (Caldwell, Eaton, & Konner, 2019; M. Konner & Eaton, 2010). The details and debates need not concern us, but the process of reasoning does. Our first publication had the word “Palaeolithic” in the title, but it was mainly about the diet of recent hunter-gatherers (RHGs), although we soon went on to compile information about physiological measures on RHGs and people in other preindustrial societies (Eaton, Konner, & Shostak, 1988). From then until now, we saw the need to test the hypotheses arising from studies of RHGs against the archaeological and palaeontological record. The parts of this record relevant to diet, activity, and physiology have become very rich, enabling much more integration of the two types of data today (Bird, Bird, & Coddling, 2016; Henry, Brooks, & Piperno, 2011; Schoeninger, 2014; Wrangham, 2017).

Since we were interested in the health implications of a proposed discordance or mismatch between a genome evolved for Palaeolithic conditions and the industrial or post-industrial conditions of today, we had to turn to other kinds of data as well. To take a simple example, even in 1985 it was clear that RHGs had diets low in refined carbohydrates. The fossil record suggested that this pathophysiological process was a late development, although the picture is more complicated today (Crittenden & Schnorr, 2017; Crittenden et al., 2017), probably due to the importance of honey in some RHG diets, possibly with significant implications for human evolution (Crittenden, 2011; F. W. Marlowe et al., 2014). For other chronic pathophysiological processes, such as atherosclerosis – once attributed mainly to saturated fats, now mainly to refined carbohydrates – other categories of data, such as epidemiology, animal experiments, and controlled clinical trials, had to be integrated with data from RHGs and data from the archaeological record.

Body composition, another fairly well-studied aspect of RHGs, was different from that in most modern humans in that the ratio of muscle to fat was higher, as were physical activity and energy throughput (Caldwell et al., 2019). The analysis of muscle insertion sites on bones in archaeological investigations supports the reduction of muscle mass and (with the bones themselves) lean body mass inferred from RHGs (Ruff & Niskanen, 2018). An early assertion of ours was that RHGs had low access to salt and low salt intake (S. B. Eaton & M. Konner, 1985). But an increasing appreciation of the potential importance of maritime environments in human evolution suggested that salt intake may have been high for some Palaeolithic

populations (Curtis W. Marean, 2010, 2014, Curtis W. Marean et al., 2007). Meanwhile, in terms of health implications, epidemiological, experimental, and clinical studies have raised questions about the advantage of very low salt intake for hypertension, heart disease, and stroke (Caldwell et al., 2019).

Thus, the algorithm for reasoning about this domain of diet, energetics, and nutritional physiology is to generate hypotheses from studies of RHGs; test them against the archaeological record; and consider the implications for pathophysiology of major departures from Palaeolithic patterns using epidemiological, animal model, and (the gold standard) randomized clinical trials. The algorithm could be informative for any reasoning about cognitive capacities suggested by the archaeological record and how they may have changed, even if the goal is to understand the normal physiology of the mind over time rather than its pathophysiology.

In addition, lest it be thought that the domain itself is far from the concerns of cognitive archaeology, psychological processes figure as both causes (food-seeking patterns, optimal foraging models, food preferences) and consequences (effects of diet and activity on mental function) of dietary and activity patterns. An intriguing specific possibility is that intake of omega-3 fatty acids and their ratio to omega-6 fatty acids in the diet favor brain development in infancy and childhood, which could have set up a synergy between development and natural selection for larger human brains, especially in coastal environments (Cunnane & Crawford, 2014). Cooking, both as a cognitive challenge and as a boon to brain growth and function by avoiding undernutrition and toxicity, could have also have set up a development-evolution as well as a culture-evolution synergy (Wrangham, 2017).

Phylogeny re-creates ontogeny

Another of my career-long concerns has been the evolution of childhood (M. Konner, 1977; Melvin Konner, 2016; M. J. Konner, 2010). I understand this to include the process of development as well as the social context of ontogeny, both of which are and have been evolving. There is no evolution of adaptive adult traits, but only modification of developmental processes leading to those traits. Furthermore, children have to survive infancy and early childhood in order to reproduce, which is much harder than surviving early adulthood.

The fossil record provides direct information about pelvis evolution, which indirectly suggests hypotheses about the evolution of childbirth, for example, about the need for birth assistance (K. Rosenberg & Trevathan, 2002; K. R. Rosenberg & Trevathan, 2018). It has been argued that the main constraint on birth timing in humans is metabolism, not anatomy (H. Dunsworth & Eccleston, 2015; H. M. Dunsworth, 2018; H. M. Dunsworth et al., 2012), and there is much more to be said about the pelvis than that it plays a role in childbirth (DeSilva & Rosenberg, 2017). But it remains true that human birth is difficult compared with that of other apes, and the most likely explanation for that is greater cephalopelvic disproportion (Trevathan, 2015).

The idea that human neonates are altricial is not controversial, although there are other unusual features of human birth and neonatal status. Human immaturity at

birth (sometimes called “secondary altriciality”) is widely recognized (Isler & van Schaik, 2012; Martin, 2007), and it explains much about the development of human infants in the first postnatal year (M. J. Konner, 2010; Sherwood & Gomez-Robles, 2017). Human life-history hallmarks such as time to sexual maturation, first birth, and senescence are approximately 50% longer in humans than great apes, but gestation length is extended very little. So human birth is clearly early by some measures, and this is probably due to limits on gestation length owing to both anatomical and metabolic constraints.

At some point in hominin evolution, fetal brain-growth rates extended as much as a year postnatally, consistent with immaturity at birth, especially but not exclusively in motor systems. It is also widely agreed that not only childbirth but infant immaturity provided selection pressure for cooperative breeding, which is much greater in humans than other catarrhines (Old World monkeys and apes), even those that have some cooperative breeding (Sarah Blaffer Hrdy, 2009; S. B. Hrdy, 2016; Isler & van Schaik, 2012; K. R. Rosenberg & Trevathan, 2018; Trevathan, 2015). A recent issue of *Physiology and Behavior* was devoted to the evolution, phenomenology, and mechanisms of nonmaternal care (M. Konner, 2018; Rosenbaum & Gettler, 2018a, 2018b). Nonmaternal care (including male parental care) may occur in as many as 30% of mammal species (Rosenbaum & Gettler, 2018a). Among primates, it is particularly common in the *Callitrichidae*, a family of New World monkeys including marmosets, and in humans. The hormonal and brain mechanisms are multiple, even within one species (M. Konner, 2018; Rosenbaum & Gettler, 2018b).

These kinds of observations can be integrated with palaeontological and archaeological evidence relating to mode of subsistence, pelvic anatomy, and brain size. For example, it has been argued on the basis of functional anatomical studies that the human female pelvis and mode of walking are a response to the need to walk while carrying a load and keeping up with others, such as occurs among RHG women on gathering expeditions, some of whom are carrying children in addition to food (Wall-Scheffler & Myers, 2017). Another example is the hypothesis that caring for helpless infants was a major selection pressure for the evolution of brain size and intelligence (M. J. Konner, 2010); new models suggest that an evolutionary synergy between adult brain size and infant postnatal brain growth related to altriciality could have produced a runaway selection on both (Piantadosi & Kidd, 2016). Neurodevelopmental and molecular-genetic evidence converge on the likelihood that altriciality and neuroplasticity increased together in hominin evolution (Sherwood & Gomez-Robles, 2017).

Of course, the ideal would be to have fossilized remains of immature individuals, but unfortunately good specimens are scarce. One is a well-preserved skeleton of *Australopithecus afarensis* found in Dikika, Ethiopia, and dated to 3.3 million ybp (Alemseged et al., 2006). Also known as “Lucy’s child,” she was probably female and 3–4 years old at death, the rough equivalent of a human 6-year-old. Her age was estimated based on ape dental development; all her deciduous teeth had erupted, and her unerupted permanent teeth included fully formed first molars and partly formed second molars. Her brain size was between 275 and 330 cc, comparable to

chimpanzees of similar dental age, compared to the 400 cc of an adult female of that species. Like *A. afarensis* adults, she had a lower body indicative of bipedal walking, but more apelike hands, arms, and shoulders, suggesting continued tree-climbing. Her skull had an exposed natural endocranial cast that reveals features of surface anatomy. Her brain growth trajectory may have departed from ape development slightly in a human-like direction.

Another specimen, an *A. africanus* dated to about 2.5 million ybp, was the first *Australopithecus* found, and is known as the Taung child. It was an almost-4-year-old, also with a naturally formed, exposed endocast (Dart, 1925). The child weighed an estimated 12 kg and was probably killed and eaten by a large raptor (Berger, 2006). This provides support for an important theory of infant attachment, which holds that its main adaptive function during our evolution was protecting the young from predators (Bowlby, 1969–1977), although that is not its only function (M. J. Konner, 2010). Study of the teeth using scanning electron microscopy suggests nutritional stress at 2.5 years of age, perhaps the time of weaning (Lacruz, Ramirez Rozzi, & Bromage, 2005). This would be a markedly earlier weaning age than among extant great apes and, probably, our last common ancestor (LCA) with chimpanzees and bonobos, perhaps reflecting increased aid to the mother, perhaps a step toward hominin cooperative breeding. But, as with the Dikika juvenile, there is no clear evidence to suggest that the Taung one had a longer immature period than the apes or the LCA.

However, their eventual descendants were selected for larger brains with complex functions: advanced puzzle-solving; tracking game without a good sense of smell; memory-guided collection of extracted foods; language and planning for group hunts; intersubjectivity for teaching; foresight for the protection and enculturation of the young in an extended childhood; intuiting the intentions of rivals; and reckoning complexities of kinship, marriage, and economic exchange. Yet we still have limited knowledge of how the phylogenesis of ontogeny produced those large brains. Early *Homo* may not have begun the lengthening of development (M. C. Dean, 2016; Smith et al., 2015). An early *Homo* mandible from Ethiopia (1.7 million ybp) has tooth eruption patterns partly resembling *H. habilis* and partly *H. erectus*, yet which fall within the extant human range (Zanolli et al., 2017). But even much later *H. erectus* did not show the fully modern pattern (M. C. Dean & Liversidge, 2015). This pattern, including slow brain maturation, does seem to be present in fossils representing a transition to early *H. sapiens* (de Castro, Modesto-Mata, & Martinon-Torres, 2015).

One almost complete skeleton of *H. ergaster* dating to 1.6 million ybp (the “Turkana boy”) was approximately 9 years old (Walker & Leakey, 1993). He was initially projected to grow over 6 feet tall, but more recent analysis suggests a more modest range of heights (Cunningham, Graves, Wescott, & McCarthy, 2018). Enamelization of his teeth suggested a shorter process of dental maturation than ours (C. Dean et al., 2001), supporting the hypothesis that fully human development came late in our evolution. The size of the spinal canal in the thoracic region suggests that he may not have been able to speak. Modern humans have a larger-diameter thoracic

spinal cord believed to reflect denser innervation for voluntary control of the diaphragm in the service of speech. The Turkana boy had a thoracic cord diameter resembling most nonhuman primates (A. MacLarnon, 1993; A. M. MacLarnon & Hewitt, 1999). However, other considerations, including the anatomy of hominin endocranial casts, suggest that *H. ergaster* had substantial symbolic capacity even if speech came later. Brain imaging and other evidence suggests that complex stone toolmaking coevolved with language and teaching (Stout, 2002; Stout, Toth et al., 2008).

A much younger child found at Mojokerto, Indonesia, is classified as *H. erectus*, a species resembling *H. ergaster*. The significance of this child's cranial capacity hinges on its age at death, which remains uncertain (Cofran & DeSilva, 2015). If it was a year or so old, its brain size would mean that at this stage we had already evolved much of the postnatal extension of rapid brain growth rates that characterizes our own species; if older, the brain would reflect an apelike pattern of growth. Neanderthal skulls and brains were not as round as modern human ones, and this difference appears in infancy (Hublin, Neubauer, & Gunz, 2015); however, the importance of this is unknown. It is evident that the fossil record of hominin development, especially brain development, remains very sketchy, making broader comparative and other indirect approaches essential (Neubauer & Hublin, 2012; Sherwood & Gomez-Robles, 2017).

The likely death of the Taung child by predation is consistent with attachment theory as mentioned, but also consistent with the idea of a "selection funnel," a time in the life cycle when the opportunity for selection due to high death rates (from infection as well as predation) is exceptional and could drive life-course, including adult adaptations. The purpose of immaturity is not only to produce a certain kind of adapted adult, but to get through the funnel; this can require tradeoff adaptations that work well in infancy, for example, but impose some adaptive cost on the resulting adult. Recent research on three different species (rats, Rhesus monkeys, and humans) suggests that the amygdala-prefrontal cortex complex is designed for infants to relate to caregivers and is particularly responsive to early social deprivation (Callaghan, Sullivan, Howell, & Tottenham, 2014).

How many such infancy-specific adaptations there are remains to be seen, but it is clear that many genes that differ between humans and chimpanzees are expressed particularly or exclusively in the brain (Caceres et al., 2003; Mitchell & Silver, 2018), some of them specific to embryonic and early postnatal life. Three examples will illustrate the potential for this research.

- 1 The search for "Human Accelerated Regions" of our genome – that is, genes that have evolved much faster since our LCA with chimpanzees than before that – has begun to produce results (Franchini & Pollard, 2017). One is *HAR1*, a gene for a non-protein-coding small RNA, which has a particular pattern of expression in the brain (Pollard et al., 2006). It is associated with a neural developmental protein called *reelin*, and they co-express in Cajal-Retzius neurons, which have a distribution in the cerebral cortex that is unique to humans.

HAR1 appears to be exclusively expressed in these neurons, and its expression is limited to the gestational period between 7 and 19 gestational weeks in human embryos, a crucial period for differentiation of the cerebral cortex.

- 2 At 12 to 14 weeks of human gestational age, there are marked left-right asymmetries in gene expression in the human embryonic cerebral cortex in areas destined anatomically to become language areas (Sun et al., 2005). These asymmetries affect the expression of as many as 27 genes. Parallel asymmetries are not found in the occipital or frontal cortex at the same stage of development, and they appear to be much less significant at 19 weeks, even in the future language areas. These genes do not seem yet to have been studied in nonhuman embryonic (e.g., great ape) brains. Research on the genetic origins of human brain laterality continues (de Kovel, Lisgo, Fisher, & Francks, 2018).
- 3 A comparison of gene expression profiles in the early development of macaques, chimpanzees, and humans reveals that there has been a process of neoteny, or stretching out, of the development of gene expression during human evolution (Somel et al., 2009). The expression of some genes significant in brain development occurs later, in fact postnatally, in human children than in the other primates (Bakken et al., 2016). This finding gives partial new life in gene-transcriptional terms to a very old idea: neoteny, namely that humans at later stages of ontogeny resemble our nonhuman ancestor at earlier ontogenetic stages.

The evolving social context of ontogeny

As with diet and activity, RHGs play a key role in models of the evolution of childhood, since despite variation, they collectively reflect our environments of evolutionary adaptedness (EEAs), and should be of interest to archaeologists. My own early work was with infants and children among the !Kung (Ju/'oansi), a San ("Bushman") group in Botswana. Early reports emphasized maternal primacy (strong quantitative predominance of maternal care) but also the other caregivers of infants (M. J. Konner, 1972); 20–25% of physical contact was with nonmaternal figures (M. J. Konner, 1976). Such caregivers respond to about half of infant crying bouts, often in tandem with the mother (Kruger & Konner, 2010). Despite the importance of nonmaternal caregivers, mothers were the main responders to infant crying and supplied 75–80% of infants' physical contact. Nevertheless, strong maternal dependency did not persist after weaning (Blurton Jones & Konner, 1973).

Fathers accounted for 10% of vocalizations to infants during the first three months, a time when American fathers did much less (M. J. Konner, 1977). !Kung fathers often hold and fondle even the young infants, but they return them to the mother when they cry and for routine care. Young children frequently interact with them. "The !Kung are classified as 'high' on closeness of fathers to infants and young children in a sample of eighty independent nonindustrial societies – they represent the upper end of the range of direct male care . . . seen in the ethnographic record" (West & Konner, 1976).

Nonparental care was also important to child survival in this group. Fathers are providers, but nuclear families with two or more children experience an energy deficit and need provisioning by others, not always relatives, with no unique role for grandmothers (Howell, 2010). Children also served as caregivers. After age 1, toddlers began to play with older children (M. J. Konner, 1976). Same-sex, same-age groups are demographically unlikely in hunter-gatherer bands and were not observed. Mixed-age play groups may be adaptive, helping to socialize younger children, offering caregiving practice to older ones, and lessening mothers' burden of care.

However, the !Kung are only one example of RHGs that might be to some extent informative of the human EEAs. Quantitative studies have been done on infants and children in at least eight other RHGs: the Hadza, Efe, Aka, Ache, Agta, Bofi, Martu, and Toba. All show maternal primacy (high physical contact and responsiveness to crying, frequent breastfeeding, late weaning) along with significant allomaternal care, and multi-age, mixed-sex play groups were important in all eight (Melvin Konner, 2016). However, some important variations occur.

The Hadza have maternal predominance (69% of holding), and also roles for fathers (7.1%) and maternal grandmothers (3.7%). Relatedness strongly predicts nonmaternal care, confirming kin selection (Crittenden & Marlowe, 2008). Some researchers have emphasized Hadza grandmothers (Hawkes, O'Connell, Jones, Alvarez, & Charnov, 1998), but fathers interacted with infants substantially more, or at least equally, controlling for residency in the camp (Crittenden & Marlowe, 2008). Genetic fathers were more involved than stepfathers, common because of the high Hadza divorce rate (Frank W. Marlowe, 2005, 2010). In the absence of a genetic father, the maternal grandmother's role was larger, and both were important food providers (Hawkes, O'Connell, & Blurton Jones, 1997; F. Marlowe, 2001; Frank W. Marlowe, 2003). Paternal care was inversely correlated to the number of single, younger women in the vicinity (Frank W. Marlowe, 1999). Hadza children have more chores, including baby care, and are much more likely than San children to forage for themselves (Crittenden, Conklin-Brittain, Zes, Schoeninger, & Marlowe, 2013).

The Efe, rainforest hunter-gatherers, had more allomaternal care than the San from birth. Other women often breastfed the infant, in addition to the mother. Close contact with the mother and others continued until the age 3. Nonmaternal figures provided 39% of physical contact at 3 weeks and 60% at 18 weeks. Infants were cared for by between 5 and 24 different people for a given infant; but infants had variable rates of allocare, ranging from none to about 65% at 3 weeks old and from about 20 to 80% after that (Tronick, Morelli, & Ivey, 1992).

Later research confirmed that the Efe are "the most extreme example of alloparenting in a foraging population," with women strongly predominating (Ivey Henry, Morelli, & Tronick, 2005). Care by children is also important; children spend about 4% of their time doing infant care between ages 4 and 12, increasing after 12 to about 8–10%. Also, much of this care is in the context of "the ubiquitous mixed-age and sex-play group of children among foragers" (Ivey Henry et al., 2005). As in the

Hadza, genetic relatedness strongly predicts nonmaternal care (Ivey, 2000). Fathers contributed more than the average nonmaternal adult, although still much less than either mothers or the sum of nonparents' care. Social contact with children tripled over the first three years, reaching 62%, yet contact with adults remained the same (Tronick et al., 1992).

Among the Aka, also tropical foragers, nonmaternal care is very prominent (Barry S. Hewlett, 1991; Meehan, Quinlan, & Malcom, 2013). "While in the camp setting, Aka one-to-four-month-olds are held by their mothers less than 40 percent of the time, are transferred to other caregivers an average of 7.3 times per hour, and have seven different caregivers" on an average day (Hewlett, 1991, p. 34). However, on expeditions outside the camp, the mother holds the infant almost 90% of the time. Food supplements breastfeeding (Meehan & Roulette, 2013). From 2 to 4 years of age, "even though mothers were the single highest contributor to child feeding, combined allomaternal contributions (i.e., contributions by fathers, grandmothers, aunts, siblings, and cousins) to child feeding was higher than that of mothers" (Jung & Fouts, 2011). Elderly female relatives fed children almost as much as mothers (Fouts & Brookshire, 2009), giving more to a child who had an infant sibling. This confirms the importance of cooperative care after weaning. Teaching and encouraging learning are common and involve multiple caregivers (B. S. Hewlett & Roulette, 2016).

However, the most distinctive feature of Aka childcare is that "fathers do more infant caregiving than . . . in any other known society" (Barry S. Hewlett, 1991). Despite this, the percentage of all infant holding accounted for by the father during the first 4 months was 22%, but 51% for the mother, and 27% for others (Hewlett, 1991, p. 79 and Table 15). The mother did for 87–96% of infant holding during net hunts. Interestingly, while in camp and not on expeditions, mothers accounted for 51% of the holding in the first 4 months, 87.5% between 8 and 12 months, and 57.3% between 13 and 18 months. About a quarter as many attachment behaviors were directed at fathers as at mothers at 8–12 months (the age of attachment formation), rising to 58.4% of the mother's amount in the second year (see also Meehan & Hawks, 2013). The behavior described as "fuss for" was coded for mothers almost eight times as often as for fathers over the whole age range, even though fewer than a fifth of incidents of "fussing for" with the mother ended in nursing.

An energy flow analysis showed that nonmaternal care decreased mothers' working energy expenditure (EE) by 28% (Meehan et al., 2013), roughly corresponding to the estimate that nonmothers do about a fourth of care (Meehan, 2005). But the reduction is mainly due to grandmothers, likely to be involved since the sample in this study consisted of *young* mothers. Fathers, surprisingly, actually increase mothers' EE, as do juveniles. There was more physical contact with grandmothers than fathers. The Aka multi-age play group could be same-sex, unlike the Hadza or San.

These details of four well-studied RHGs illustrate the range of infant and childcare in this type of society, but a few others are worth mentioning. Among the Ache of the Paraguayan rainforest, fathers are very important in providing food, but also give some direct care, although mothers do much more of that. Mixed-age,

mixed-sex play groups are important. For adolescents, godparent-like relationships become significant. The Agta of the mountainous northern Philippines offer a test of maternal primacy since women do almost half the hunting, yet mothers do most of the care. Fathers are less involved than among the Aka or even the San, maternal hunting notwithstanding. Mixed-age, mixed-sex groups are found, and adolescent girls sometimes carry toddlers. Childcare in these cultures and other RHGs have been reviewed in some detail (Melvin Konner, 2016).

In sum, maternal primacy applies to all RHGs studied, although nonmaternal care is always present and important, but variable. Father care (direct care, providing food, defense, etc.) can in some settings be interchangeable with grandmother care, and other adults play varied roles. Mixed-age groups of children mitigate maternal costs, and sometimes siblings are assigned baby and toddler care. The general view of humans as obligatory cooperative breeders (Sarah Blaffer Hrdy, 2009) is supported for hunter-gatherers, who as a group of cultures reflect many possible human EEAs. Archaeologists might take this into account when making inferences about the context of human and protohuman development, at least until the broad spectrum revolution made higher population densities common. Different recent cultures might be more relevant as models after that stage.

It is worth noting that if the context of development in the aforementioned RHGs is taken as representative of our species' basic adaptation, then it is partly consistent with a probably much older pattern that I have called the catarrhine mother-infant complex, "characterized by a hemochorial placenta; singleton birth with rare twinning; 24-hour physical contact for weeks to months and close proximity until weaning; nursing at least three times per hour while awake and at least once at night; weaning no earlier than 25–30 percent of the age at female sexual maturity; gradual transition to a multi-aged juvenile play group; and variable but usually little direct male care" (Konner, 2010, p. 383). The most noteworthy departure from this model by RHGs is in a very large increase in cooperative breeding (Sarah Blaffer Hrdy, 2009; S. B. Hrdy, 2016), including a substantially increased role for fathers (Konner, 2010, Chapter 17).

Unfortunately, hypotheses about the social context of childhood cannot be tested directly against the fossil and archaeological record, as can be done with diet or juvenile development itself. But we have to hope that those studying this record will find the comparative information about RHGs and nonhuman catarrhines (Old World monkeys and apes) to be useful in their reasoning about the past. Also, while research on the consequences of departures from these basic patterns of childcare (discordance or mismatch) is possible, there is nothing comparable to the evidence about the consequences of mismatch for diet and activity levels. There is no doubt that variations in childhood experience within the normal human range must have consequences for adult adaptation; we have limited information about what the consequences are and how they work.

Research on mechanisms considered in an evolutionary context, such as the developing hypothalamo-pituitary-adrenocortical axis central to the stress response (Flinn, 2006) and epigenetic markers affecting gene expression, should gradually

make inferences more possible (Hernando-Herraez, Garcia-Perez, Sharp, & Marques-Bonet, 2015; Perez, Rubinstein, & Dulac, 2016). The comparative neurobiology of parenting has also become a focus of research, which should aid inferences about the prehistory of parental behavior and its associated emotions (Rilling & Mascaró, 2017; Rilling & Young, 2014). Some neuroscientists are studying the brain basis of responses to the *Kinderschema*, sometimes called “the cute response” (Kringelbach, Stark, Alexander, Bornstein, & Stein, 2016), and have begun to speak of the neurobiology of parental instincts in the orbitofrontal cortex and other circuits (Mascaró, Hackett, Gouzoules, Lori, & Rilling, 2014; Parsons, Young, Stein, & Kringelbach, 2017; Young et al., 2016; Young et al., 2017). This kind of research should help archaeologists think about the relationship between parenting and brain evolution.

Finally, recent comparative research on human and other primate brains has shed light on what had to happen not only genetically but neurobiologically for our brains to emerge from those of our likely LCA. The arcuate fasciculus, a major fiber tract connecting different language areas of the brain, is much larger in humans than chimpanzees (Rilling, Glasser et al., 2008). Resting state brain activity in chimps (the default mode network) shows higher levels of activity in ventromedial prefrontal cortex and lower levels in left-cortical areas involved in language, suggesting that the default mode of chimpanzees involves emotion-related episodic memory retrieval, but not language and conceptual processing (Rilling et al., 2007). Neural circuits involving in-group and out-group cognitions and emotions are being elucidated (Rilling, Dagenais, Goldsmith, Glenn, & Pagnoni, 2008), and the marked behavioral differences in empathy between the closely related bonobos and chimpanzees have also been correlated with anatomical differences in a specific neural system (Rilling et al., 2012). And in a line of research directly linking archaeology with brain function in an unprecedented way, people learning to make stone handaxes of an Acheulean type, among other stone-knapping procedures, are being studied using current brain imaging methods (Stout, 2016; Stout, Hecht, Khreisheh, Bradley, & Chaminade, 2015; Stout & Hecht, 2017; Stout & Khreisheh, 2015). The findings have important implications for archaeologists’ thinking about what the protohuman brain was like in earlier species of the genus *Homo*, as well as how such toolmaking abilities may relate to the evolution of language circuits in the brain. The role of oxytocin in the complex social behavior of bonobos and humans is another fast-developing area of research that will facilitate inferences about the evolution of behavior (De Dreu et al., 2010; De Dreu, Greer, Van Kleef, Shalvi, & Handgraaf, 2011; Moscovice, Surbeck, Fruth, Hohmann, & Deschner, 2018; Moscovice & Ziegler, 2012).

Clearly this is an exciting time for cognitive and other psychological aspects of the fossil and archaeological record, one in which major research efforts guided by evolutionary theory and concerns are addressing relevant aspects of physiology and development using a variety of methods that go beyond the results of excavations. Although the latter must be the ultimate arbiter of what happened in evolution and prehistory, the opportunity for thinking in new ways about those excavated facts is greater than it has ever been.

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3

LIFE HISTORY EVOLUTION IN HOMININS

Jon Oxford and David C. Geary

Life history theory

The evolution and expression of humans' unique life history, including an extended developmental period, brain growth, and lifespan, are an integral part of the cognitive and social abilities that have allowed humans to inhabit an extraordinary number of ecological niches. Yet, our understanding of how this suite of traits evolved and the factors that influence their proximate development is incomplete. We describe what is known about human life history and how the fossil record can be used to make inferences about its evolution. Before doing so, we begin with an overview of the basics of life history theory, with focus on the economics of finite energy allocation to growth and reproduction, resulting in characteristic suites of traits that are simplistically described as *fast* or *slow*. We then turn to these patterns among primates and humans, and finally the likely patterns in our ancestors.

Life history evolution

Life history theory encompasses the evolution and expression of species-typical and individual variation, in the adaptive timing of life events, with particular focus on variation in the age-schedules of mortality, fertility, and growth (Hill & Kaplan, 1999). Major life history traits include the age at maturation, pattern of reproductive investment (e.g., focus on mating or parenting), and overall lifespan (Roff, 1992; Stearns, 1992, 2000). The timing of these aspects of life history involves trade-offs, that is, the competitive allocation of limited energetic (i.e., time and calories) resources to somatic versus reproductive effort (Alexander, 1987; Reznick, 1985; Williams, 1966). Somatic effort refers to resources devoted to growth during development and the maintenance of physical systems throughout the lifespan; extended physical health in adulthood is especially important for species that reproduce more

than once (i.e., iteroparity). Reproductive effort is energy expended on mating, parenting, and inclusive fitness (i.e., helping of kin).

A key aspect of these tradeoffs is that investing in reproduction comes at a cost to future reproduction through relatively less somatic maintenance (Williams, 1966). Among male mammals, for instance, intense competition for social status and access to females or for control of the resources that females need to reproduce (e.g., breeding sites) is associated with faster aging and a shorter lifespan relative to same-species females that compete less intensely but invest more in offspring (Clutton-Brock & Isvaran, 2007; Lemaître, Gaillard, Pemberton, & Clutton-Brock, 2014). Although often less intense than male-male competition, in terms of depletion of somatic resources, females' investment in offspring can also compromise their health and lifespan (e.g., De Gaudemar, 1998). Even with heavy investment in offspring, there are tradeoffs; parental investment in one offspring usually reduces energy available for future offspring; therefore parental investment reduces mating effort (Trivers, 1972). The pattern of growth and relative investment in reproduction versus somatic maintenance follow species-specific patterns, but are expressed within a reactance norm. That is, the proximate here-and-now expression of these patterns is influenced by social and ecological conditions, within a genetically influenced range (e.g., somewhat earlier or somewhat later age of first reproduction (Charnov & Bergigan, 1993; Montiglio, Dammhahn, Messier, & Réale, 2018).

As an example of the importance of ecological conditions, consider the experimental manipulation of extrinsic mortality. In an artificial selection experiment with fruit flies (*Drosophila melanogaster*), Stearns, Ackermann, Doebeli, and Kaiser (2000) created a high adult mortality condition, by killing 90% of the population twice a week for four years, and a low killing condition in which only 10% of the flies were killed over the same period. Fruit flies in the high mortality condition evolved shorter lifespans, decreased maturation time and physical size, and earlier peak fecundity. The opposite was found for the low adult mortality condition. This study illustrates that life history traits are not independent and tend to covary, resulting in a continuum from *live fast die young* to *live long die old* (Promislow & Harvey, 1990).

Primate life history

In the following subsection, we describe characteristic patterns of growth and development in primate life histories, and their relation to adult reproductive ecology. The goal is to provide a framework for later discussion of uniquely human traits in the subsequent section.

Slow life history

As found for dolphins, whales, and elephants, primate life histories are characterized by slower growth, later age at first reproduction, modest rates of reproduction, extensive parental care, enhanced learning and sociality, longer lifespans, and lower

fertility than other mammals (Jones, 2011; Smith & Tompkins, 1995). Many of these life history characteristics are related to the social nature of most primate groups, which act to reduce extrinsic mortality by reducing predation and protecting food sources (Schaik, 1983). As found by Stearns et al. (2000) for fruit flies, lower extrinsic mortality is associated with a long developmental period in primates, and in fact the longest juvenile period for mammals of their body size (Harvey & Clutton-Brock, 1985). Even with lower extrinsic mortality, there is still a risk of dying before having the opportunity to reproduce. This risk means that there must be a substantive benefit to slow maturation, most likely resulting from the opportunity to accumulate reproductive potential, that is, to elaborate traits that will aid in adult reproduction (e.g., competing for mates, investing in offspring). For primates, this includes increased body size and the development of more sophisticated social skills making the individual more competitive as an adult. Of course, primate life history variations are related to adult reproductive ecology.

Body size

Generally, mammalian body size is related to the length of development, as it takes longer to accrue the energetic resources to become bigger (Harvey & Nee, 1991). As primate young are dependent on energy derived from their mothers, higher quality offspring with larger bodies, and longer periods of growth and development, are easier to afford for larger primate mothers, though at a cost of the time it takes the mother to grow larger (Charnov & Berrigan, 1993). At the same time, heavy investment in larger and more socially sophisticated offspring comes with the cost of fewer offspring over the females' lifespan.

In any case, larger body size at birth and weaning is generally associated with higher long-term survival and reproductive prospects for both sexes, as well as a larger body size in adulthood. Body size can be particularly important for male primates that engage in physical male-male competition for access to reproductive females (Carranza, 1996; Stearns, 1992). The mating dynamics of these polygynous species are consistently related to sex differences in life history (Leigh, 2004). Males of these species are larger than females in adulthood; they have a longer developmental period and often a more pronounced growth spurt (gaining muscle and fat) before reproductive maturation, and have shorter lifespans. Monogamous species, on the other hand, tend to be monomorphic, with similar patterns of development and similar lifespans (Clutton-Brock, Harvey, & Rudder, 1977).

Brain size

For primates, a higher frequency of tool use, behavioral innovation, and social learning capacities are associated with larger brain size (Reader & Laland, 2002). Primate cortical expansion has been suggested to be a product of exploiting a skill-intensive forging niche (Parker & Gibson, 1977) and the socio-cognitive competencies of living in large social groups (Humphrey, 1976). Importantly, it is the

primate neocortex that is implicated in association formation, planning, sensory integration, behavioral flexibility, problem solving, and memory (Joffe & Dunbar, 1997). For adults the size of the neocortex correlates with indices of social complexity, such as group-size, number of females, grooming clique size, frequency of coalitions, prevalence of social play, tactical deception, and frequency of social learning (Barton, 1996; Dunbar & Shultz, 2007; Walker, Burger, Wagner, & Von Rueden, 2006). Interestingly, primate neocortices have been found to relate to mating systems, such that greater intensity of one-on-one male-male competition was inversely related to neocortex size, particularly in monogamous species (Schillaci, 2008). Monogamous relationships may require a more intense and intricate social relationship, but also facilitate greater biparental care (at least in some primates) and a longer period of growth. At the same time, male-male coalitional competition is associated with a smaller sex difference in physical size, and the associated social dynamics may have also contributed to brain evolution (Plavcan, Van Schaik, & Kappeler, 1995).

Developmental activity

Infancy, the period from birth to weaning, is largely a period of growth for primates. However, the juvenile period, from weaning to reproductive maturity, is marked by attainment of cognitive and physical skills necessary for self-provisioning and reproduction in adulthood. The development of skills necessary for effective foraging can take significant time and social learning (see Gunst, Leca, Boinski, & Frigaszy, 2010), as can the social skills needed to be successful as an adult. Therefore, the primary function of the juvenile period in primates is socialization and refinement of skills needed in adulthood, which vary with the social structure of the group and adult reproductive ecology. The length of the juvenile period covaries most consistently with foraging complexity and population density (Walker et al., 2006).

Social learning during the juvenile period is critical for accruing complex foraging skills, especially for apes that specialize in hard to get and process foods (Rapaport & Brown, 2008). For example, orangutans (*Pongo pygmaeus*) have food traditions and skill cultures that result from extensive vertical transmission (across generations) of successful foraging strategies (Jaeggi et al., 2010). Juveniles that are deprived of diet-related knowledge from mother during development are not able to identify and process foods. Indeed, due to human interference, motherless juveniles are increasingly common. The complexity of foraging strategies makes rehabilitation challenging (Russon, 2002).

In addition to foraging, a juvenile primate needs to develop varying degrees of social competency, depending on the complexity of the group – for example, knowledge of dominance, rank, reconciliation, and how to form alliances and cooperate with others (Joffe, 1997). Many of these competencies are acquired in the context of social play. The frequency of social play is associated with the amount of postnatal brain growth, in particular, the relative size of the neocortex and the

cerebellum (Montgomery, 2014). Play is thought to allow the practice and refinement of social and physical skills, in relative safety (Smith, 1982).

Human life history

In the context of primates, humans create the largest and most complex social groups. These groups are unique in that they include multiple tolerant males and multiple females, and have extensive biparental care, altricial infants, multigenerational bilateral kinship networks, culture with language and tools, concealed ovulation, and menopause (Flinn, Geary, & Ward, 2005; Flinn, Quinlan, Coe, & Ward, 2007; Geary, 2000). The associated life history adaptations are in most ways at the extreme end of the anthropoid *live slow and die old* continuum. Among these traits are the largest brains, with the longest subadult period, latest age at first reproduction, and longest lifespan (Robson, van Schaik, & Hawkes, 2006).

At the same time, humans deviate from the slow pattern with increased fertility, through pooling resources needed for reproduction among others in the group (Reiches et al., 2009). This type of “cooperative breeding” (Hrdy, 2011; Kramer, 2010) or “biocultural reproduction” (Bogin, Bragg, & Kuzawa, 2014) reduces the mothers’ energetic expenditure by an estimated 14 to 29% (ibid.), allowing her to reproduce every two to three years (Bogin et al., 2014) as compared to every five to six years for chimpanzees (Kaplan et al., 2000). By reducing interbirth intervals, stacking multiple dependent offspring and their care, humans are said to “work in double time compared to our closest relatives, the great apes” (Dean & Smith, 2009, p. 115). Humans’ sociality allows us to invest in both the quality and quantity of our offspring; we “have our cake and eat it too” (Kuzawa & Bragg, 2012).

Life history development

In Table 3.1, we provide some of the key features of human life history development and briefly discuss each of them in the following sections.

Table 3.1 Key life history traits human and great apes

	Humans	Great Apes
Gestation and Birth	<ul style="list-style-type: none"> • 266 days • Secondarily altricial 	<ul style="list-style-type: none"> • Range from 237 to 260 days
Infancy	<ul style="list-style-type: none"> • Birth to weaning, which occurs significantly before first molars • Lactation shortened, resulting in shorter interbirth interval, and stacked offspring • Rapid brain and body growth • Unique globularity phase shortly after birth 	<ul style="list-style-type: none"> • Birth to first molar emergence, and juvenile stage begins • Weaning takes significantly longer • No extended provisioning, milk to adult foods

Life history evolution in hominins

	<i>Humans</i>	<i>Great Apes</i>
Childhood	<ul style="list-style-type: none"> • Weaning to first molar around 6 years • Rapid brain growth maintained • Slowed somatic growth to compensate for peak metabolic brain cost • Provisioned by group with high quality, easily digested foods • Language, and theory of mind • Peak brain volume and subsequent experience driven synaptic pruning • Mother returns to reproductive cycling 	<ul style="list-style-type: none"> • Not present
Juvenile Phase	<ul style="list-style-type: none"> • First molar to puberty • Cortical maturation social and competitive skills elaboration • Play 	<ul style="list-style-type: none"> • First molar to puberty • Social and foraging skills elaboration • Play
Adolescence	<ul style="list-style-type: none"> • Puberty to around 20 years • Growth rebound with uniquely human growth spurt • Brain maturation continues, especially prefrontal cortex • Important for learning human reproductive ecology • Second permanent molar around 12 • Third permanent molar around 18–21 	<ul style="list-style-type: none"> • Largely absent in great apes
Adulthood	<ul style="list-style-type: none"> • First birth around 18–20 • Some brain maturation continues • Reproduction characterized by provisioning of mothers, and alloparental care by grandmothers, fathers, bilateral kinship networks, siblings 	<ul style="list-style-type: none"> • First birth shortly after puberty • One offspring at a time

Gestation

Gestation lengths in extant large-bodied apes are somewhat similar, suggesting phylogenetic constraints on gestation length (ranging from 266 days to 237 days for humans and chimpanzees, respectively (Robson et al., 2006). However, larger mothers have larger offspring, and the human brain is larger in absolute terms than that of great apes and our hominid ancestors (Leigh, 2004). While larger, at birth it is still only 25% of adult volume, as compared to 50% for chimpanzees (Bogin & Smith, 2000), a constraint imposed by maternal metabolism during gestation (Dunsworth, Warrener, Deacon, Ellison, & Pontzer, 2012) or the mothers'

bipedally adapted pelvis (Lovejoy, 1981). Importantly, the degree of brain immaturity serves as an index of learning and sensitivity to environmental influences in the subsequent discussion of hominins; in other words, brain immaturity at birth is associated with an extended postnatal period of brain development and greater complexity of the social and ecological skills that must be acquired during development.

Infancy

Human infancy spans the first three years of life, from birth to weaning, and is characterized initially by rapid growth of both brain and body. While the duration of postnatal brain growth is similar for humans and chimpanzees, one major difference is in the expense of maintaining high fetal rates of growth (Leigh, 2004). In addition to postnatal rate of change, the cranial base flexes and the parietal and cerebellar regions expand rapidly, contributing to neurocranial globularity, the shape and structure that defines modern humans' cranium (Neubauer, Hublin, & Gunz, 2018). It is important to note that throughout development, regional differences in brain maturation and interconnectivity result in the emergence of cognitive and behavioral traits in humans that are not found in chimpanzees or other apes, due in part to globularity.

As mentioned earlier, relative to other primates, the human infant is born *secondarily altricial* (undeveloped), in terms of brain development and general motor skills. And yet, they are remarkably precocial in other ways, especially in the ability to engage care providers (Smith, 2018). Moreover, earlier maturation of prefrontal connections during infancy, in humans relative to chimpanzees, may enhance the developmental impact of complex social interactions in shaping neuronal connectivity through the acquisition of experience-dependent knowledge and skills (Sakai et al., 2011, 2013). It should be noted that the social complexity of human groups provides an enriched developmental environment, with a variety of care providers (e.g., alloparents, grandmothers, fathers, and siblings), obligating intense, prolonged provisioning with face-to-face carrying, which is thought to be foundational for social development, including providing the preconditions for language (Ragir, 1985). Toward the end of infancy, physical development slows to allow additional resources for continued brain development (Crews & Bogin, 2010; Kuzawa et al., 2014).

Childhood

For great apes, the juvenile stage is marked by the first molar eruption, which corresponds with the age of weaning and 90% brain growth (Robson & Wood, 2008). First molars are important for apes, as once weaned they must eat adult foods. Human children will not erupt their first molars until around 6 years. The intervening period between weaning and juvenile stage (3–6.9 years) is unique to humans and is referred to as childhood (Bogin & Smith, 2000). At weaning, human children

are not capable of feeding themselves, with a limited battery of teeth, limited gut surface area, and a sharply increasing demand for energy to support brain growth (Kuzawa et al., 2014; Smith, 2018). One result is a strong dependency on provisioning by others (in addition to their mother) of easily chewed and digested protein and fat dense foods (Bogin & Smith, 2000).

During childhood, the brain is growing rapidly, and children exhibit rapid learning in some domains, such as language, social learning, and theory of mind (the ability to make inferences about the thoughts and feelings of others). These competencies have been proposed to contribute to human specific cultural intelligence (Herrmann et al., 2007). Kuwaza and colleagues (2014) showed that during this time, the relationship between somatic and brain growth is inverse, such that when glucose uptake by the brain peaks, somatic growth is at its lowest (see Bogin & Smith, 2000). At around 4 years of age, the brain uses nearly double the glucose of adults, which corresponds to synaptogenesis or the overexpression of connections among neurons and neural systems that are slowly reduced into adulthood through experience-dependent pruning (Chugani, 1998; Greenough, Black, Wallace, Development, & Jun, 1987). Before the 7th year, brain growth is virtually completed, at least in terms of absolute size, and regional changes in maturation result in a cognitive transition that supports the learning of culture-specific social and economic skills (Bogin & Smith, 1996). In contemporary societies, the conclusion of childhood occurs when children begin formal education, beginning the formal process of enculturation.

In an evolutionary sense, the slowing of somatic growth during childhood has been hypothesized to provide additional time for increasing embodied capital, that is, developing larger brains, and acquiring more cognitive, social, and physical skills (Kaplan, Hill, Lancaster, & Hurtado, 2000). The childhood phase also stretches growth and development over a longer period, thereby reducing the daily caloric needs (Gurven & Walker, 2006). More generally, childhood allows the mother to return to reproductive cycling, shortening the interval between births (Bogin & Smith, 1996).

Juvenile or middle childhood

The juvenile phase is roughly the elementary school years or from the end of childhood to the beginning of puberty. The juvenile stage for humans is marked by slow somatic growth, and the onset of cortical maturation through pruning of neural connections that are not used, as well as increased motor coordination, attentional control, planning, pragmatic language skills, and increasing social competence (Del Giudice, Angeleri, & Manera, 2009). Regional differences in brain maturation relate to inhibitory control and “sense making” supporting social interest and prosociality (Campbell, 2011). Socially, there is an increase in sex-specific segregation and an increase in sexually differentiated play activities, social behaviors, and the ways in which social competition and cooperation are expressed (Geary, Byrd-Craven, Hoard, Vigil, & Numtee, 2003).

Adolescence

The juvenile phase ends with puberty and a characteristic somatic rebounding growth spurt. While some other primates also show growth spurts, there are many unique aspects of the human growth spurt (Leigh, 1996). Unlike chimpanzees and other apes, humans delay reproduction for another ten years, at least in Western societies. In all, the delayed development and reproduction of juvenile and adolescent stages must provide a substantive benefit, including time to learn and practice the complex economic, social, and sexual skills required for effective food production, reproduction, and parenting in adulthood (Bogin, 2015; Geary, 2002).

Brain development during adolescence highlights processes that are crucial to the functional significance of delaying reproduction, such as a delay in neocortical myelination (complete by reproductive maturity in apes), which continues well beyond late adolescence, allowing continued sensitivity and adaptation to variation in the social and cultural environment (Miller et al., 2012). The continued refinement of adult skills is motivated by gonadal hormones and hyper-responsiveness of the striatal reward system (Galvan, 2010), enhancing interest in and emotional impact of social relationships. These include continued development and refinement (e.g., pruning neuronal connections) in the brain systems that support social cognition (Blakemore & Mills, 2014). Most complex executive functions of the prefrontal cortex such as reasoning, motivation, and judgment continually develop throughout childhood, adolescence, and young adulthood; these uniquely human functions and their emergence may be aided by late persistence of exuberant synapses in the prefrontal cortex (Huttenlocher & Dabholkar, 1997). There are also sex-specific patterns of brain maturation during this period that correspond to sex-specific social and ecological niches occupied by adults in traditional societies (Geary, 2018).

Adulthood

During parts of development and in adulthood, the life histories of boys and men and girls and women proceed somewhat differently (Geary, 2002). In traditional contexts, women often have their first child at about 18 years – a few years later for men – and thereafter humans fit the basic pattern found in other great apes. These similarities include giving birth to relatively few offspring and investing heavily in them during development. Differences, as noted, include increased fertility relative to other great apes (through earlier weaning) and a prolonged provisioning of young, resulting in stacked dependent offspring; weaning an infant early in the human fashion spreads the cost of feeding among others in the group (Burkart, Hrdy, & Van Schaik, 2009; Hrdy, 2011), allowing fathers and grandmothers and even siblings to pool energetic resources (Geary, 2000; Hawkes et al., 1998; Reiche et al., 2009; Sear & Mace, 2008).

The evolution of the human mating systems is somewhat enigmatic, as many aspects are not found in extant apes (Isler & Schaik, 2012), primarily groups

comprising multiple males and multiple females, which are also characterized by longer-term male–female bonds, paternal investment, and alloparental care (Alexander, 1990; Flinn et al., 2007). Without those unique characteristics, humans could not invest so heavily in an expensive brain and produce enough offspring to maintain the population (Isler & van Schaik, 2012). The next section will address what evidence exists in the fossil record, but it may be of interest to point out that humans exhibit other traits that facilitate our unique reproductive ecology and may provide insight into our evolution (for review, Flinn et al., 2005; Geary, 2005) – for example, traits such as the loss of estrus with concealed or cryptic ovulation (Alexander & Noonan, 1979), female orgasm, permanently enlarged breasts and buttocks in women, moderate testes, relative loss of sexual dimorphism, romantic love with suppression of mate seeking mechanisms (Fletcher, Simpson, Campbell, & Overall, 2015), grandmothers, bilateral kinship recognition, moral emotions, and complex social learning and culture.

Hominin fossil record

For ease of presentation, we focus on three successful groups of hominin. “Early hominin” will refer to the genus *Australopithecus*, “early *Homo*” to *H. erectus/ergaster*, and “later *Homo*” to *H. neanderthalensis* to distinguish between archaic *Homo* and modern humans. These categories are useful for describing the evidence for a shift in life history, mating systems, as well as brain and body growth and development, which indicate important behavioral and cognitive changes that resulted in the many unique aspects of modern humans.

Early hominin

The first adaptive radiation of early hominin comprises a group of fossils that come from the genus *Australopithecus*, which persisted for about 2 million years, from about 4.2 million ybp. *Australopithecine* species showed variations, but generally have the same suite of anatomical features. They were terrestrial bipeds retaining some features for climbing, with large chewing teeth and jaws (i.e., indicating tough, fibrous foods), small bodies, strong sexual dimorphism, and small hindlimbs relative to forelimbs (McHenry & Coffing, 2000).

Brain size and development

Australopith brains, inferred from crania, were only slightly larger than those of great apes – 420 to 550 cc, which is about a third the size of modern humans (McHenry & Coffing, 2000). Accordingly, it is estimated that Australopith brains were slightly larger than that of chimpanzees at birth (DeSilva & Lesnik, 2008), though evidence is lacking as to changes in growth patterns (Smith, 1990). Australopiths were predicted to have erupted the first permanent molar at around 3–3.5 years, comparable

to chimpanzees, as opposed to 6 for human growth schedules (Kelley & Schwartz, 2012; Smith, 1991).

Skull endocasts suggest that brain reapportionment may have occurred in Australopiths, as measured by the lunate sulcus, which is in the human-like as opposed to chimpanzee-like position (Holloway, Clarke, & Tobias, 2004; though see Falk, 1987). The human-like position represents a reduced primary visual cortex, and expanded parietal and temporal cortices, regions important for human-like complex cognitive skills, such as language, aspects of theory of mind, and complex spatial abilities. Further, Australopith endocasts reproduce a middle frontal sulcus found in human-like fashion as opposed to ape, which suggests the expansion and reorganization of the frontal cortex (Falk, 2014). It is possible that brain reorganization in Australopiths and the cognitive consequences underlie the subsequent brain expansion in the genus *Homo* (Hublin, Neubauer, & Gunz, 2015).

Mating system

Sexual dimorphism in hominid species has been taken as evidence of polygyny (Foley & Lee, 1989; Lovejoy, 1981). Dimorphisms in body and canine size are the most predictive variables in estimating the intensity of male-male competition among anthropoid primates (Plavcan, 2012). In species in which males can monopolize multiple females through larger size and weaponry, such as gorillas, dimorphism is extreme, but monogamous species tend to be monomorphic. Determining sex of fossils is difficult, but for Australopiths, general consensus is that they were strongly dimorphic in body size, with males ranging from 31% to 55% larger than females, compared to 15% in modern humans (Ruff, 2002), though paradoxically lacking not only canine-size dimorphism, but the canine honing complex (Kimbel & Deleuzene, 2009). The loss of canines as weapons in intraspecific competition between males is a defining feature of hominin evolution, arising shortly after the common ancestor to chimpanzees and humans (Lovejoy, 2009). Canine-size dimorphism has been shown to be less pronounced in species in which agonistic encounters are decided by coalitions, rather than dyads, such as chimpanzees (Plavcan et al., 1995).

The magnitude of the sexual dimorphism for these Australopithecines suggests intense one-on-one male-male competition, which in turn is most consistent with either single-male harems or solitary males that controlled territories that encompassed the territories of several females (Ghiglieri, 1987). Unlike men, male chimpanzees and bonobos show little to no paternal investment. And unlike women, female chimpanzees and bonobos show conspicuous estrous swellings and mate promiscuously. On the basis of these and other differences, Geary & Flinn (2001) proposed our ancestors might have been more similar to our distant cousin, the gorilla (also see Geary, Bailey, & Oxford, 2011; Lovejoy, 1981). All in all, Australopith fossils provide evidence that the human mating system was yet to emerge, which is thought to be a key in releasing energetic constraints on the cost of bigger brains (Isler & van Schaik, 2012).

Early Homo

The earliest evidence for a shift in life history variables, in the direction of modern humans, comes from the emergence of *Homo*, in particular *Homo erectus*. Between 2.5 and 1.8 million ybp stone tools appeared, brains expanded, sexual dimorphism in overall body size decreased, human-like limb proportions with long legs and reduced abdomens emerged, masticatory apparatus and teeth were reduced, evidence of carnivory appeared, and crania began to share more unique features with later *Homo* (Antón & Snodgrass, 2012; Hublin et al., 2015; McHenry & Coffing, 2000). Many of these adaptations, especially carnivory, allowed widespread dispersal, as well as the first hominin dispersal out of Africa (Antón, 2003; Bar-Yosef & Belfer-Cohen, 2001).

Energy needs

While there is quite a bit of variation between early and late *erectus*, the larger average body size is well-established, with a range from 148 to 285 cm, weighing 46 to 68 kg (Antón, 2003). Total estimated energy expenditure of hominins increased substantially with *H. erectus*. Assuming a chimpanzee-like foraging strategy, based on body size alone, *H. erectus* is estimated to necessitate a 40–45% increase in energy expenditure over *Australopiths*, if human-like foraging strategy is assumed, 80–85% (Leonard & Robertson, 1997). Given brain and body size, *H. erectus* likely used 17% of resting energy for the brain, as opposed to 11% for *Australopithecines* (Antón, 2003). The expensive tissue hypothesis proposes that increased meat and fat consumption was necessary to compensate for the increased energy needs and resulted in reduction in the size of the energy demanding digestive tract necessary for primarily vegetarian diets (Aiello & Wheeler, 1995). Further, there is supporting evidence that human specific tapeworm phylogeny diverged between .78 thousand ybp and 1.78 million ybp, suggesting a change in diet (see Antón, 2003). There is some evidence that *H. erectus* may have used fire to increase the nutritive value of food or for protection (Wrangham & Carmody, 2010).

Isler and van Shaik (2012) used extant mammal and primate data to show that primates with a hominid lifestyle face a “gray ceiling” that limits brain size to around 600–700 cc, as they could not reproduce fast enough to grow or sustain the population. Early specimens of *H. erectus* had an estimated cranial capacity of around 700 cc, later above 1,000 cc (Antón, 2003). The latter indicates that *H. erectus* exhibited significant differences in ecological and social variables, by around 1.8 million ybp, releasing constraints on brain growth, which could be achieved by increased energy budgets, most likely due to social structure and consistent acquisition of higher quality food stuffs (e.g., meat); growing a larger brain also has implications for life history variables.

Brain and development

For *Homo erectus*, brain size was still tightly linked to body size, a relationship that does not appear to change until later in hominin evolution. While the brain was larger, it showed morphological differences including low brain height, elongated

and wider proportions, less developed temporoparietal areas and narrower frontal lobes, strong posterior projection of the occipital lobes, and anterior positioning of the cerebellar fossa (Hublin et al., 2015) – more simply described as shorter and less rounded (Antón, 2003). These changes suggest substantive changes in the cognitive and social sophistication of *H. erectus*.

Representative fossils of *H. erectus* have been estimated to have first molar emergence around 4.5 years old, which is about a year later than *A. afarensis*, but not in line with humans at around 6 years (Dean et al., 2001; Schwartz, 2012). Additionally, second molar emergence was estimated to occur around 9 years, which is not typical of any living primate, but would describe a maturation pattern intermediate between chimpanzees at 6.5 and humans at around 12 years (Dean & Smith, 2009). Coqueugniot, Hublin, Veillon, Houet, and Jacob (2004) examined an exceptionally well preserved *H. erectus* infant, Mojokerto child. At an estimated age of 1 year, it had achieved 72–84% of adult endocranial capacity, as compared to 50% for a human infant, indicating that brain growth occurred much faster, and likely infants were not altricial, in a human fashion. With only a short duration of postnatal brain development and therefore lower plasticity in response to social and ecological variation, it is unlikely that they had cognitive skills comparable to those of modern humans; this is perhaps evidence that they lacked the human language capacity (Ragir, 1985), as the structural pathways supporting motor and speech functions of language show protracted development through childhood and adolescence in modern humans (Paus et al., 1999).

Smith's (1993) analysis of an adolescent male (KNM-WT 15000) suggests the *H. erectus* did not have an adolescent growth spurt. When the “Turkana boy” died c. 1.5 million ybp, his upper canines were in place, and he had recently erupted second permanent molars, which places him in early adolescence. However, his age estimates were discordant with a dental age (11 years), a bone age (13 years), and a stature age (15 years). That his stature was so large at a young age suggests that the distinctive human growth suppression in childhood and the adolescent spurt had not yet evolved (also see Dean & Smith, 2009; Thompson & Nelson, 2011). If it is true that *H. erectus* lacked somatic suppression of growth in childhood, then it stands to reason that they were unable to support multiple dependents in the modern human fashion.

Reproductive strategy

Body size dimorphism in *H. erectus* was significantly reduced, approaching modern human proportion, importantly with females getting substantially larger (Antón, 2003; Leonard & Robertson, 1997; McHenry, 1992). The primary cause is thought to reflect the fact that having larger females allows more energy transfer to offspring at a reduced cost to the mother (Charnov & Berrigan, 1993). A larger mother also allows mothers to carry altricial infants to an older age (Kramer, 1998). All in all, being a *H. erectus* mother has been estimated to increase energetic costs of reproduction, lactation, gestation, and non-reproductive periods 50% over an Australopith

mother (Aiello & Key, 2002). The greater needs of *H. erectus* females suggest that in addition to dietary shifts, social shifts may have been necessary to meet the energetic needs of reproduction. The grandmother hypothesis proposes that long post-menopausal life may have originated with *H. erectus* (O'Connell, Hawkes, & Blurton Jones, 1999). Others suggest provisioning and cooperative care would be necessary (Aiello & Key, 2002). Still others suggest cooperative breeding with some degree of monogamy (Kramer & Russell, 2015).

Later Homo

Hominin brain size continues to increase, independent of body size, over the last 600,000–150,000 years (Ruff, Trinkaus, & Holliday, 1997). Defining species after *H. erectus* is somewhat contentious (Lieberman, McBratney, & Krovitz, 2002), but generally they are characterized by a combination of primitive traits, such as robust cranial superstructures, and modern traits, such as large cranial capacity, and include categories such as *H. antecessor*, *H. heidelbergensis*, and *H. neanderthalensis*. For the last extinct relative, Neanderthal, brain sizes are at the upper range for modern humans, and they exhibited behavioral complexity, for example, burying of dead, which provides for a more robust fossil record (Smith, 2018).

Brain and development

Depending on reports (for discussion see Robson & Wood, 2008), Neanderthal dental development falls within human ranges (Guatelli-Steinberg, Reid, Bishop, & Larsen, 2005) or was faster (Ramirez Rozzi & Bermudez de Castro, 2004; Smith et al., 2010; Smith, Toussaint, Reid, Olejniczak, & Hublin, 2007). If as proposed by Coqueugniot et al. (2004) the Neanderthal pattern was at the upper end of the modern human range, suggesting faster brain development, it would have important implications for understanding their cognitive skill set. For example, in humans, abnormally accelerated brain growth of autism spectrum disorders in the first year of life results in cognitive, linguistic, and social impairments (Courchesne et al., 2007). Neubauer and Hublin (2012) propose that the mechanism behind rapid brain growth in autism highlights the importance of secondary altriciality for humans, and if the Neanderthal exhibited rapid brain growth they may have lacked modern human social competencies, putting them at a competitive disadvantage relative to modern humans.

In addition to potential differences in the rate of brain growth, at birth the shape and volume of endocasts are almost identical; the human brain enters a globularization phase directly after birth and ends with eruption of deciduous dentition (Neubauer & Hublin, 2012). The Neanderthal brain in adulthood retained most of the archaic characteristics, with widening of frontal lobes, elevated shape, and reduction of occipital lobes, whereas modern human brains are characterized by a more globular shape, resulting in the bulging of the parietal and cerebellar areas (Neubauer et al., 2018). Bastir et al. (2011) showed that modern humans display a

proportionally larger cerebellum, larger olfactory bulbs, larger temporal poles, and a wider orbitofrontal cortex.

Interestingly, the cerebellum matures very early and is implicated in developmental disorders like autism, ADHD, and developmental dyslexia (Stoodley, 2016). In autism, the cerebellum is one of the most consistent sites of abnormality (D'Mello & Stoodley, 2015). The cerebellum forms multiple closed-loop circuits with cerebral cortical regions that unpin movement, language, and social processing, impacting the core symptoms of social and communication deficits, as well as repetitive stereotyped behavior. A recent meta-analysis found that the cerebellum is especially important for executive processing and meaning giving in high-level mentalizing, such as in the context of making inferences about traits and stereotypes of other persons and groups, or thinking strategically about the past or hypothetical events (Van Overwalle, Baetens, Mariën, & Vandekerckhove, 2014). It has been suggested that the modern human cerebellum may have provided greater computational efficiency for coping with an increasingly complex cultural and conceptual environment (Weaver, 2005).

Genetic evidence for Neanderthal individuals is available and indicates a list of substitutions that became fixed in modern humans after the ancestral separation (Prüfer et al., 2014), occurring between 270,000 and 440,000 years ago (Green et al., 2010). Relative to modern humans there was less genetic variation, suggesting small, isolated populations (Castellano et al., 2014), and some indication of inbreeding (Prüfer et al., 2014). Dysregulation of several genetic features fixed in modern humans, but derived from Neanderthal, has been associated with brain development and cognitive function (Castellano et al., 2014; Green et al., 2010; Maricic et al., 2013). In particular, mutations in *NRG3* have been associated with schizophrenia and thereby human specific cognitive functions. Mutations in *CADPS2* and *AUTS2* have been associated with autism, which affects social interaction, communication, activity, and interest patterns, and thereby human crucial sociality and cultural capacity. The specific structure and function of the *FOXP2* gene that characterizes nearly all present-day humans is absent or polymorphic in Neanderthals. *FOXP2* is required for normal development of speech and language in modern humans, and shows an estimated date of fixation at around 200,000 years ago (Carroll, 2003).

Modern human emergence

The earliest evidence of modern human developmental patterns, based on dental evidence of age at death, degree of tooth eruption, and crown formation times, comes from a *Homo sapiens* juvenile from Jebel Irhoud, Morocco, dated 160,000 years ago (Smith, Tafforeau, et al., 2007). However, an analysis including individuals from Jebel Irhoud suggests that the globular brain shape did not reach present-day variation until 100,000–35,000 years ago. The parallel between the emergence of behavioral modernity in the archaeological record suggests evolutionary changes in brain development were crucial to our species (Neubauer et al., 2018).

Conclusion

Life history theory describes the economics of limited energy allocation to growth, reproduction, and death (Hill & Kaplan, 1999). Importantly, traits such as the length of gestation, age at weaning, age at maturity, and lifespan tend to covary and result in suites of traits that we referred to simply as fast or slow (Promislow & Harvey, 1990). Primates are at the slow end of the continuum, exhibiting a strong positive relationship between sizes of the brain and body and birth weight, and the time they take in gestation, age at weaning, age at maturity, and lifespan (Harvey & Clutton-Brock, 1985). Longer lifespans are associated with a greater reliance on social learning (Street, Navarrete, Reader, & Laland, 2017). Social learning and even some aspects of culture are present in great apes; the value is in saving time and energy across the lifespan in accruing sophisticated competencies. Both time and energy are fundamental to the economics of life history allocation. Human life history is adapted to maximize the social and ecological impact on the developing brain, with adaptations to support the expense and requisite time. Of particular importance are the human family and social groups, which provision and provide a protected environment to maximize the flow of information and practice of supporting competencies (Flinn & Ward, 2005).

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4

EVOLUTION OF HORMONAL MECHANISMS FOR HUMAN FAMILY RELATIONSHIPS

Heather Habecker and Mark V. Flinn

Humans are the species that raises children.
(M. Konner, 1991, p. 427)

Humans are similar to most mammals in having intense maternal care including breastfeeding of an altricial (helpless) offspring, with some support from other relatives. Beyond the shared mammal/primate commonality, however, humans exhibit a suite of highly unusual traits. We are the only species characterized by the *combination* of stable breeding bonds, extensive paternal effort in a multi-male group, lengthy childhood, extended bilateral kin recognition, grandparenting, and controlled exchange of mates among kin groups (Alexander, 1979, 1990b; Chapais, 2008; Flinn, 2011). These characteristics are important for theoretical and pragmatic understanding of family relationships and the supporting cognitive, emotional, and physiological mechanisms; they also provide critical insights into the puzzle of human evolution.

In this chapter we first review a general model for the evolution of human mating, parenting, and kinship patterns based on a process of runaway social selection (Alexander, 2005; Flinn & Alexander, 2007; Flinn, 2017). We then evaluate the physiological mechanisms that underpin these central aspects of our sociality. Our objectives include providing important information and ideas from neuroendocrinology that contribute to understanding the evolution of the human family.

Brain, childhood, and family

Evolution of mind in the family crèche

Information processing (intelligence) and social communication (language) are core human adaptations. By all measures the human brain is an astonishing organ. Its cortex comprises about 30 billion neurons of 200 different types, each of which is

interlinked by about a thousand synapses, resulting in $>10^{15}$ connections working at rates of up to 10^{10} interactions per second (Edelman, 2006; Koch, 1999; Williams & Herrup, 1988). Quantifying the transduction of these biophysical actions into specific mental activities – i.e., thoughts and emotional feelings – is difficult, but it is likely that humans have more information processing capacity than any other species (Roth & Dicke, 2005).

The human brain evolved at a rapid pace: Hominin cranial capacity tripled (from an average of about 450 cc to 1350 cc) in less than two million years (Lee & Wolpoff, 2003) – roughly 100,000 neurons and supportive cells per generation. Structural changes such as increased convolutions, thickly myelinated cortical neurons, lateral asymmetries, increased von Economo neurons, expansion of the neocortex, and enhanced integration of the cerebellum also were significant (Allman, 1999; Amodio & Frith, 2006; Schoenemann, 2006; Sherwood et al., 2006; Spocter et al., 2010). In comparison with most other parts of the human genome, selection on genes involved with brain development was especially intense (Gilbert, Dobyns, & Lahn, 2005).

The human brain has high metabolic costs: about 50% of an infant's and 20% of an adult's energetic resources are used to support neurological activity (Aiello & Wheeler, 1995; Elia, 1992; Holliday, 1986; Kuzawa et al., 2014; Leonard, Snodgrass, & Robertson, 2007). Thoughts are not free; the high levels of glucose and other energetic nutrients required to fuel human cognition involve significant trade-offs (Campbell, 2010). Although the increase in energetic resources allocated to the brain was accompanied by a corresponding decrease in digestive tissue, this does not explain what the selective pressures for enhanced information processing were, nor why the resources were not reallocated to direct reproductive function (Aiello & Wheeler, 1995). The obstetric difficulties associated with birthing a large-headed infant generate additional problems (Rosenberg & Trevathan, 2002). The selective advantages of increased intelligence must have been high to overcome these costs.

The human brain, in short, is a big evolutionary puzzle. It is developmentally and metabolically expensive. It evolved rapidly and consistently. And it enables unusual human cognitive abilities such as language, empathy, foresight, consciousness, mental time travel, creativity, and theory of mind (ToM). Advantages of a larger brain may include enhanced information processing capacities to contend with ecological pressures that involve sexually dimorphic activities such as hunting and complex foraging (Kaplan & Robson, 2002). There is little evidence, however, of sufficient domain-specific enlargement of those parts of the brain associated with selective pressures from the physical environment, including subsistence activities (Adolphs, 2003; Geary & Huffman, 2002). Indeed, human cognition has little to distinguish itself in the way of specialized ecological talents. Our remarkable aptitudes for tool use and other technical behaviors depend primarily on more general aptitudes for social learning and fluid intelligence (Geary, 2005). Furthermore, the emergence of tools in the archaeological record predates increased cranial capacity in hominins. A large brain may have been sexually selected because intelligence was an attractive trait for mate choice (Miller, 2000). However, there is little sexual dimorphism in encephalization quotients or intelligence psychometrics (Jensen, 1998), nor is there a

clear reason why brains would have been a target for sexual selection driven by mate choice uniquely and consistently among hominins.

The human brain did not evolve as an isolated trait. Concomitant changes in other traits provide clues to what selective pressures were important during hominin evolution. Changes in life history patterns accompanied the evident increases in information processing and communication during the Pleistocene. Gestation (pregnancy) was lengthened, but the resultant infant was even more altricial (Rosenberg, 2004). Human infants must be carried, fed, and protected for a long period in comparison with those of other primates. And yet humans have shorter interbirth intervals than other hominoids (Hrdy, 2007; Galdikas & Wood, 1990). Human childhood and adolescence are also exceptionally lengthy (Bogin, 1999; Del Giudice, 2009; Leigh, 2004). This extension of the juvenile period appears costly in evolutionary terms. The delay of reproduction until at least 15 years of age involves prolonged exposure to extrinsic causes of mortality and longer generation intervals. Parental and other kin investments continue for an unusually long time, often well into adulthood and perhaps even after the death of the parents. Like the big brain, human life history is an evolutionary puzzle (Hill & Kaplan, 1999; Mace, 2000; Muehlenbein & Flinn, 2010).

A child must accumulate energetic resources necessary for physical somatic growth. Whether the lengthening of the human juvenile period was an unavoidable response to an increasing shortage of calories, however, is uncertain. Other hominoids (chimpanzees, gorillas, orangutans) grow at similar overall rates, but mature earlier (Leigh, 2004). Increased body fat is associated with earlier puberty for girls, although psychological and genetic factors are also important (Walvoord, 2010), and the relation is not significant for boys (Lee et al., 2010; cf. Li et al., 2018). Moreover, low birth weight is associated with earlier puberty in some conditions (Karaolis-Danckert, Buyken, Sonntag, & Kroke, 2009). The peculiarities of the human growth curve are also difficult to explain from a simple model of food scarcity – the general timing of growth spurts does not appear linked to a pattern of caloric surpluses. Hence, although it is clear that human female growth and reproductive maturation are sensitive to fat accumulation (Sloboda, Hart, Doherty, Pennell, & Hickey, 2007), the lengthening of the juvenile period during human evolution seems likely to have involved more than simple energetic constraints on growth.

The life history stage of human childhood appears to be an adaptation, at least in part, for the function of enabling cognitive development, including complex social skills and emotional regulation (Alexander, 1987; Bjorklund & Pellegrini, 2002; Del Giudice, 2009; Flinn, 2004; Konner, 2010). The human child is an extraordinarily social creature, motivated by and highly sensitive to interpersonal relationships (Gopnik, Meltzoff, & Kuhl, 1999). Learning, practice, and experience are imperative for social success. The information processing capacity used for human social interactions is considerable, and perhaps significantly greater than that involved with foraging, locomotion, toolmaking, and other subsistence skills, highlighting the link between social success and reproductive success in humans (Rilling et al., 2002; Roth & Dicke, 2005; Schoenemann, 2006).

A child needs to master complex dynamic social tasks such as developing appropriate cognitive and emotional responses during interactions with peers and adults in the local community (Bugental, 2000). The learning environments that facilitate and channel these aspects of human mental phenotypic plasticity appear to take on a special importance (Posner, 2005). Much of the data required for the social behavior necessary to be successful as a human cannot be “preprogrammed” into specific, detailed, fixed responses. Social cleverness in a fast-paced, cumulative cultural environment must contend with dynamic, constantly shifting strategies of friends and enemies, and hence needs information from experiential social learning and creative scenario-building (Del Giudice, 2009; Flinn, 2006).

To summarize our argument to this point, human childhood may be viewed as a life history stage that is necessary for acquiring the information and practice to build and refine the mental algorithms critical for negotiating the social relationships that are key to individual reproductive success in humans (Flinn, Muehlenbein, & Ponzi, 2009; Geary & Flinn, 2001). Mastering the social environment presents special challenges for the human child. Social competence is difficult because the targets (other children and adults) are constantly changing and similarly equipped with theory of mind and other cognitive abilities. Selection for flexible cognitive problem solving would also enhance complementary development of more sophisticated ecological skills such as hunting and complex extractive foraging, which may have increased selection for these traits further.

Human social relationships are especially complex because they involve extensive coalitions. We are extraordinarily cooperative, most exceptionally and importantly in regard to competition with other groups (Alexander, 1979, 2006; Bowles, 2009). Humans are unique in being the only species that engages in group-against-group play (Alexander, 1990a, 1990b), including team sports. This trait is cross-culturally universal, emerges early in child development, and often is the object of tremendous collective effort.

The family environment is a primary source and mediator of the ontogeny of information processing abilities, including social competencies and group cooperation. Human biology has been profoundly affected by our evolutionary history as unusually social creatures, immersed in networks of family, kin, and dynamic, inter-community coalitions.

The human family

All human societies recognize kinship as a key organizational principle (Brown, 1991). All languages have kinship terminologies and concomitant expectations of obligations and reciprocity (Fortes, 1969; Murdock, 1949). Human kinship systems appear unique in the universal recognition of both bilateral (maternal and paternal) and multigenerational kin, with a general trend for co-residence of male kin, but include a dozen or more major variants (Flinn & Low, 1986; Murdock, 1949). These aspects of human kinship link families into broader cooperative systems, and provide additional opportunities for alloparental care during the long social childhood.

Three species-distinctive characteristics stand out as unusually important in this regard: (1) fathering, i.e., extensive and specific investment by males, (2) grandparenting, and (3) networks of kinship that extend among communities and involve affinal (ties by marriage) and consanguineal (ties by blood) relationships.

Fathers

Mammals that live in groups with multiple males – such as chimpanzees (*Pan troglodytes*) – usually have little or no paternal care, because the non-exclusivity of mating relationships obscures paternity (Alexander, 1974; Clutton-Brock, 1991). In contrast, it is common for human fathers to provide protection, information, food, and social status for their children (Gray & Anderson, 2010). Paternal care in humans appears to be facilitated by relatively stable pair-bonds, which not only involve cooperation between mates that often endures over the lifespan, but require an unusual type of cooperation among co-residing males – respect for each other’s mating relationships.

The relatively exclusive mating relationships that are characteristic of most human societies (Flinn & Low, 1986) generate natural factions within the group. Mating relationships also can create alliances in human groups, linking two families or clans together (e.g., Chagnon, 1966). By way of comparison, in chimpanzee communities it is difficult for even the most dominant male to monopolize an estrous female; usually most of the males in a community mate with most of the females (Goodall, 1986; Mitani, Watts, & Amsler, 2010). Chimpanzee males in effect “share” a common interest in the community’s females and their offspring. Human groups, in contrast, are composed of family units, each with distinct reproductive interests. Human males do not typically share mating access to all the group’s females; consequently, there are usually reliable cues identifying which children are their genetic offspring, and which are those of other males (for exceptions see Beckerman & Valentine, 2002; Walker, Flinn, & Hill, 2010). Because humans live in multi-male groups, yet often maintain stable and exclusive mating relationships, the potential for fission along family lines is high. Still, human groups overcome this inherent conflict between family units to form large, stable coalitions.

This unusual tolerance among co-residential males and their families stands in contrast to the norm of polygamous mate competition in group-living nonhuman primates. Selection pressures favoring such tolerance are uncertain, but likely involve the importance of both male parental investment (Alexander, 1990a, 1990b) and male coalitions for intraspecific conflict (Alexander, 1990a, 1990b; Bernhard, Fischbacher, & Fehr, 2006; Flinn, Geary, & Ward, 2005; Gavrilets & Vose, 2006; Wrangham, 1999).

The advantages of intensive parenting, including paternal protection and other care, require a most unusual pattern of mating relationships: moderately exclusive pair-bonding in multiple-male groups. No other primate (or mammal) that lives in large, cooperative multiple-reproductive-male groups has such extensive male parental care targeted at specific offspring. Competition for females in multiple-male groups usually results in low confidence of paternity (e.g., bonobos and chimpanzees). Males forming exclusive “pair-bonds” in multiple-male groups would

provide cues of non-paternity to other males, and hence place their offspring in great danger of infanticide (Hrdy, 1999). Paternal care is most likely to be favored by natural selection in conditions where males can identify their offspring with sufficient probability to offset the costs of investment, although reciprocity with mates is also likely to be involved (Flinn, 2015; Geary & Flinn, 2001; Smuts & Smuts, 1993). Humans exhibit a unique nested family social structure, involving complex reciprocity among males and females that may also restrict direct competition for mates among group members.

It is difficult to imagine how this system could be maintained in the absence of another unusual human trait: concealed or “cryptic” ovulation (Alexander & Noonan, 1979). Human groups tend to be male philopatric (males tending to remain in their natal groups), resulting in extensive male kin alliances, useful for competing against other groups of male kin (LeBlanc, 2003; Wrangham & Peterson, 1996). Females also have complex alliances, but usually are not involved directly in the overt physical aggression characteristic of intergroup relations (Campbell, 2002; Geary & Flinn, 2002). Relationships among human brothers and sisters are life-long even where residence is in different communities, in contrast with the absence of significant ties or apparent kin recognition after emigration in other hominoids. Parents, grandparents, and other kin may be especially important for the child’s mental development of social and cultural maps because they can be relied upon as landmarks who provide relatively honest information. From this perspective, the evolutionary significance of the human family in regard to child development is viewed more as a nest from which social skills may be acquired than just as an economic unit centered on the sexual division of labor (Flinn & Ward, 2005).

In summary, the care-providing roles of fathers are unusually important in humans, particularly in regard to protection and social power, but are flexible components of the human family, and are linked with the roles of other relatives, including grandparents. In addition to the effects of direct parental care, paternity provides the basis for critical bilateral kinship links that extend across communities and generations. The neuroendocrine mechanisms that underpin human paternal and grandparental psychology are not well studied, but likely involve the common mammalian affiliative hormones oxytocin and arginine vasopressin, with additional influence from the hypothalamic-pituitary-gonadal and hypothalamic-pituitary-adrenal systems (Gray & Campbell, 2009). We focus on these hormonal systems in the latter part of this chapter.

Grandparents

Grandparents and grandoffspring share 25% of their genes identical by descent; this constitutes a significant opportunity for kin selection. Few species, however, live in groups with multiple overlapping generations of kin. Fewer still have significant social relationships among individuals two or more generations apart. Humans appear rather exceptional in this regard. Grandparenting is cross-culturally ubiquitous and pervasive (Murdock, 1967; Sear, Mace, & McGregor, 2000; Voland, Chasiotis, & Schiefenhövel,

2005). Our life histories allow for significant generational overlaps, including an apparent extended post-reproductive stage in women facilitated by the unique human physiological adaptation of menopause (Alexander, 1974, 1987; Hawkes, 2003).

The significance of emotional bonding between grandparents and grandchildren is beyond doubt. The evolved functions are uncertain, but likely involve the exceptional importance of long-term extensive and intensive investment for the human child. The emotional and cognitive processes that guide grand-relationships evolved because they enhanced survival and eventual reproductive success of grandchildren. Leaving children with grandparents and other alloparental care providers allows parents to pursue productive activities that would otherwise be risky or difficult when encumbered with childcare. In addition to the physical basics of food, protection, and hygienic care, psychological development of the human child is strongly influenced by the dynamics of the social environment (Dunn, 2004; Hetherington, 2003a, 2003b; Konner, 1991, 2010). Grandparents may have knowledge and experience that are important and useful for helping grandchildren and other relatives to survive (Sear et al., 2000; Sear & Mace, 2008) and succeed in social competition (Coe, 2003; Volland et al., 2005). Humans are unusual in the critical role of kin in alloparental care and group coalitions (Hrdy, 2009).

Extended kinship and control of mating relationships

The direct application of theory from evolutionary biology to human marriage behavior and mating strategies is . . . not possible until the theory is modified to take into consideration the interdependency of individuals . . . and how their interdependency – coalition alliances – structures human mating behavior.

(Chagnon, 1979, p. 88)

Human communities are composed of families embedded in complex kin networks. The importance of kinship in traditional societies is paramount; social power is primarily contingent upon support from relatives. Complex kinship alliances are arguably the most distinguishing social behavioral characteristic of humans in pre-industrial cultures, and yet it is rarely discussed in evolutionary psychology or evolutionary economics. Reciprocity in all its various guises (for review see Alexander, 2006) is inextricably bound up with kinship in traditional societies, perhaps most importantly in regard to the control of mating in the institution of marriage. The vast majority of non-industrial cultures in the *Ethnographic Atlas* (Murdock, 1967) have rules and preferences specifying what categories of relatives are appropriate for mating/marriage; these rules and preferences involve issues of resultant kin ties in addition to inbreeding avoidance (for ethnographic examples see Chagnon, 1966; Gough, 1959). It is worth emphasizing that humans are unique in the regulation of mating relationships by kin groups. The reason for controlling who mates with whom is that humans, uniquely, rely on kinship ties for alliances among groups (Fortes, 1949; Lévi-Straus, 1949/1969). Mates are usually obtained via strategic negotiation between kin groups. No other species exhibits systematic preferences and prohibitions for mating relationships between specific types of cousins.

If human ancestors had intergroup relations similar to that of chimpanzees (Mitani et al., 2010; Wrangham, 1999; Wrangham & Peterson, 1996), it would have been difficult to make even the first steps toward cooperative alliances among males (and females) in different communities. An adult male attempting to establish a relationship with another group likely would be killed as he entered their range. Somehow our ancestors overcame such obstacles to the first steps toward the core human adaptation of intercommunity alliances. It is possible that our ancestors did not have hostile intergroup relations; this seems unlikely, however, on both empirical (LeBlanc, 2001) and theoretical (Alexander, 1990a, 1990b) grounds. Hence, with increasing importance, the most potent factor driving the evolution of the psychological, social, and cultural mechanisms enabling the formation of increasingly large and complex coalitions was competition with other such coalitions (Alexander, 1990a, 1990b; Flinn et al., 2005; Gavrilets & Vose, 2006).

Recognition of kinship among individuals residing in different communities is key to intergroup cooperation. Humans are different from other hominoids in the co-evolutionary development of: (a) stable and moderately exclusive breeding bonds, (b) bilateral kin recognition and relationships, and (c) reciprocity and kin links among co-resident families (Alexander, 1990a, 1990b; Chapais, 2008; Flinn, Quinlan, Ward, & Coe, 2007). In short, the family was a critical building block for the evolution of more complex communities, such as patrilocal bands and tribes (Chagnon, 1979), with flexible residence choice with kin in multiple communities and apparent intentional cultivation of ties with relatives in multiple locations (e.g., Chagnon, Lynch, Shenk, Hames & Flinn, 2017; Macfarlan, Walker, Flinn, & Chagnon, 2014; Walker et al., 2013).

Hard evidence for the evolutionary trajectory of human family, kinship, and intergroup relations is scarce and indirect; neurobiology and physiology, however, provide some important clues.

Neurological and physiological mechanisms

Neuroendocrine systems may be viewed as complex sets of mechanisms designed by natural selection to communicate information among cells and tissues. Steroid and peptide hormones, associated neurotransmitters, and other chemical messengers guide behaviors of mammals in many important ways (Ellison, 2009; Lee, Macbeth, Pagani, & Young, 2009; Panksepp, 2009). For example, analysis of patterns of hormone levels in naturalistic contexts can provide important insights into the evolutionary functions of the neuroendocrine mechanisms that guide human behaviors. Here we focus on human family relationships.

Hormonal basis for attachment and family love

Some of the most precious human feelings are stimulated by close social relationships: a mother holding her newborn infant; brothers reunited after a long absence; lovers entangled in each other's arms. Natural selection has designed our neurobiological

mechanisms, in concert with our endocrine systems, to generate potent sensations in our interactions with these most evolutionarily significant individuals. We share with our primate relatives the same basic hormones and neurotransmitters that underlie these mental gifts. But our unique evolutionary history has modified us to respond to different circumstances and situations; we experience reward and punishment for somewhat different stimuli than our phylogenetic cousins. Chimpanzees and humans share the same delight – the sensational reward – when biting into a ripe, juicy mango, but the endocrine, neurological, and associated emotional responses of a human father to the birth of his child (e.g., Gray, Kahlenberg, Barrett, Lipson, & Ellison, 2002; Storey, Walsh, Quinton, & Wynne-Edwards, 2000) are likely to be quite different from those of a chimpanzee male. Happiness for a human (Buss, 2000) has many unique designs, such as romantic love (Fisher, Aron, & Brown, 2006), that involve modification of the neurological receptors and processors of shared endogenous messengers from our phylogenetic heritage. Generally, many of the characteristics of humans' unique sociality, especially attachment and bonding, are modulated by these shared neurobiological systems.

Attachment and bonding are central in the lives of the social mammals. Basic to survival and reproduction, interdependent family relationships are the fabric of the social networks that permit individuals to maintain cooperative relationships over time. Although attachments can provide security and relief from stress, close relationships also exert pressures on individuals to whom they respond. It should not be surprising, therefore, that the neuroendocrine mechanisms underlying attachment and stress are intimately related to one another. And although more is known about the stress response systems than the affiliative systems, we are beginning to get some important insights into the neuroendocrine mechanisms that underpin human relationships, particularly oxytocin (OT) and arginine-vasopressin (AVP) (Lee et al., 2009; Panksepp, 2004).

OT and AVP are nine-amino-acid polypeptides, or nonapeptides, that function as both neurotransmitter and hormone. OT-like peptides, which include AVP and at least 16 other variants, are present in amphibians, reptiles, birds, nonmammalian vertebrates, sharks, and the lungfish, as well as some mollusks, annelids, and insects (Gimpl & Fahrenholz, 2001). The earthworm (*Eisenia foetida*) is the most primitive species from which an OT-related peptide has been isolated, where it is related to induction of egg-laying behavior (Gimpl & Fahrenholz, 2001). OT is one of the more recent nonapeptides to have evolved (Insel, 2010) and is present in all placental mammals, some marsupials, and the ratfish (Gimpl & Fahrenholz, 2001).

Synthesis of OT occurs primarily in the hypothalamus, although it is also known to be synthesized in several peripheral nervous system (PNS) tissues including the testis, ovary, uterus, and placenta (Gimpl & Fahrenholz, 2001). The hypothalamus is located beneath the thalamus and is an integral component of the limbic system. It regulates metabolic, reproductive, and sociobehavioral processes via its projections to central nervous system (CNS) structures as well as its projections to the pituitary gland. From these projections, axon terminals release OT and AVP directly into the bloodstream via capillaries in the posterior pituitary. OT released into the bloodstream then acts on targets in the PNS, where it is important for parturition,

analgesia, and other major functions. These regions also modulate various brain structures important in social cognition and behavior.

Behavioral changes as a result of OT activity are modulated by the binding of OT to receptors in target neurons. This process can be regulated by availability of receptors for OT to bind with. If OT is binding to the OT receptor (OTR), then regulation of transcription of the OTR gene can regulate OT action; however, OT can also bind to AVP receptors, which can also regulate the action of OT in the central and peripheral nervous systems. Therefore, variation across species in the location of receptors that OT can bind with can have an impact on species-specific social behavior. While there is likely less variation in receptor distribution within a species and, subsequently, less explanatory power of variation in receptor distribution to account for intra-species behavioral variation, understanding species-typical locations of OT receptors in the brain can still inform the study of intra-species behavioral variation. For example, although all humans likely have OT receptors in the same brain areas, differential transcription of receptors in these regions (i.e., making more or less receptors for OT to bind to) can result in human behavioral differences. As such, a thorough understanding of where OT receptors are in the human brain can inform how OT may have evolved to modulate attachment and bonding in humans, particularly with family members.

Most neuropeptide receptor distributions are fairly conserved across mammals; however, OTR distribution is an exception and can vary even among closely related species (Insel, 2010; Insel & Shapiro, 1992). Extensive research on voles demonstrates the relationship between OTR distribution and behavior between closely related species (Insel & Shapiro, 1992). The prairie vole (*Microtus ochrogaster*) is monogamous and shows high infant care from both parents. Partners bond after mating, while the polygamous montane vole (*Microtus montanus*) does not bond with its partner after mating and engages in little infant care after parturition (Insel & Shapiro, 1992). Along with other monogamous species like the marmoset and the California mouse, the prairie vole has OTR sites in the ventral pallidum (VP), particularly in the nucleus accumbens (NAcc), an area critical for dopaminergic reward-related behaviors (Insel, 2010; Insel & Shapiro, 1992). The montane vole, on the other hand, shows little OT binding in these areas (Insel, 2010; Insel & Shapiro, 1992). Thus pair-bonding and parental behavior have an intrinsic reward potential in the prairie vole that is absent or reduced in the montane vole. These differences in reward potential and subsequent behavior are, in part, the result of variation in the distribution of OTR, which can vary between even closely related species. Similarly, individual differences in behavior, while not as dependent on differences in OTR distribution, may reflect differences in OTR density within these regions of the brain.

Localization of OTRs in the human brain has proven complex. Studies on non-primate animal models, particularly studies with less social rodents, may not necessarily reflect OTR locations in the human brain, as this can vary across species. Notable differences between human and rodent OTR distribution as detected by studies using radioligand assay and immunohistochemistry are listed in Tables 4.1 and 4.2 (both tables modified from Gimpl & Fahrenholz, 2001).

Table 4.1 Exclusive differences in OTR distribution between rodents and humans

<i>Differential brain regions</i>	<i>Level of OTR binding</i>
OTR binding in humans (not rodents)	
Basal nucleus of Meynert	high
Substantia nigra pars compacta	high
Globus pallidus	medium
Anterior medial preoptic area*	medium
Posterior hypothalamic area	medium
Hypoglossal nucleus	medium
Central gray	low
Dorsal raphe nucleus	low
Medial mammillary nucleus	low
OTR binding in rodents (not humans)	
Ventral subiculum	high
Bed nucleus of stria terminalis	high
Central amygdaloid nucleus	high
Parasubiculum and presubiculum	medium
Caudoputamen	medium
Amygdaloid-hippocampal area	medium-low
Basolateral amygdaloid nucleus	medium-low
Dorsal subiculum	medium-low
Nucleus accumbens	low
Medial amygdaloid nucleus	low
Entorhinal/perirhinal area	low
Temporal cortex	low
Supramammillary nucleus	low
Pituitary gland	low
Frontal cortex	very low

* Conflicting data. Shahrokh, Zhang, Diorio, Gratton, and Meaney (2010) report OTR in female rats during maternal behavior; Gimpl and Fahrenholz (2001) report no OTR binding in the rat brain.

fMRI studies using intranasal OT (IN-OT) may also indicate locations of OT binding in the human brain. A recent meta analysis of 73 fMRI studies of IN-OT administration has been summarized in Table 4.3; note that the sample contains healthy populations as well as clinical groups (Grace, Rossell, Heinrichs, Kordsachia, & Labuschagne, 2018). Out of the regions identified, the amygdala was most often correlated with IN-OT administration in these studies, slightly more often

Table 4.2 Relative differences in OTR distribution between rodents and humans

Differential brain regions	Level of OTR binding	
	Human	Rodent
OTR binding higher in humans		
Nucleus of the solitary tract	high	very low
Lateral septal nucleus	high	low
Substantia gelatinosa trigeminal nucleus	high	low
Lateral mammillary nucleus	medium	low
OTR binding higher in rodents		
Peduncular cortex	very low	high
Ventral pallidum cell groups	medium	high
Medial tuberal nucleus	low	medium
Inferior olive nucleus	very low	low

Table 4.3 Brain regions with changes in BOLD activity following intranasal OT administration

Region activity	Frequency	Increased activity	Decreased activity
Amygdala	53% (39/73)	26% (19/73)	34% (25/73)*
Insula	25% (18/73)	12% (9/73)	8% (6/73)
Midbrain and basal ganglia	19% (14/73)	15% (11/73)	4% (3/73)
Anterior cingulate cortex	18% (13/73)	10% (7/73)	3% (2/73)
Temporal gyrus	14% (10/73)	14% (10/73)	14% (10/73)
Prefrontal cortex	12% (9/73)	—	—
Inferior and orbitofrontal cortex	11% (8/73)	10% (7/73)	—
Precuneus	8% (6/73)	5% (4/73)	1% (1/73)

* Note that the “Increased activity” and “Decreased activity” columns may exceed the “Frequency” column for a given region since some studies may report both increases and decreases in activity. Data come directly from Grace et al. (2018).

with decreased BOLD responses to IN-OT (Grace et al., 2018). Decreases in BOLD signal occurred twice as often in males (reported in 18% (13/73) studies) as in females (reported in 7% (5/73) studies) but just as often in both sexes when amygdala activity increased following IN-OT administration (reported in 11% (8/73) of studies, with four showing the effect in women and four reporting the effect in men) (Grace et al., 2018). In fact, most brain regions identified in these studies showed significant sex differences in BOLD signal following IN-OT (Grace et al., 2018). The PFC was noted as the most sexually dimorphic among the regions discussed (Grace

et al., 2018). Similarly, there were often mixed results with regard to whether or not activity in these regions showed increases or decreases in activity following IN-OT administration. Approximately twice as often IN-OT was associated with increased activity (as opposed to decreased activity) when considering all regions identified. In fact, IN-OT was associated more often with increases in activity in all regions discussed except the amygdala (Grace et al., 2018).

Data from fMRI, immunohistochemistry, and radioligand assays suggest a complex relationship between OTergic activity and the amygdala, which may partially account for the variation observed in amygdala activity across these studies (i.e., sometimes OT was associated with a decrease in amygdala activity but other times was associated with an increase). Research from Whalen et al. (2004) suggests that the specific stimulus that the amygdala may be responsive to is the size of the white scleral field of the eye (i.e., the whites of the eyes) when processing emotion, especially fear. While data using fMRI and peripheral OT measures were difficult to interpret there is evidence that OTergic activity may be important in processing fearful or negative emotions in faces (Lancaster et al., 2018). Similarly, OT has been shown to be important for eye gaze, as demonstrated by studies on autistic populations, who often have difficulties maintaining eye gaze and processing social information (Davies, Dapretto, Sigman, Sepeta, & Bookheimer, 2011). Aside from the amygdala, no other region was identified in both the OTR localization studies and the fMRI studies except for the septal nuclei. The human septal nuclei were identified as having OTRs by Gimpl and Fahrenholz (2001), currently the most comprehensive review of OTR localization; they have also been identified using more accurate methods of OTR localization (Boccia, Petrusz, Suzuki, Marson, & Pedersen, 2013), as well as in fMRI research.

As mentioned, OT activity can be regulated by availability of receptors, which is itself regulated by transcription of the genes that code for the receptors, such as the OTR gene. Research shows that levels of OTR mRNA resulting from OTR gene expression correlate to density of OTR expression in the brain (Kimura et al., 1992) and that region-specific distribution of expressed OTR is regulated by transcription of the OTR gene (Gainer, 2012; Young et al., 1997).

The rate of gene transcription can be, and often is, influenced by transcription factor binding sites (TFBSs), which are regions of DNA that regulate the transcription of genes. As such, regulation of gene transcription has the potential to produce incredible functional variety in cells and cellular systems within and between species without necessitating drastic changes to the structure of receptors or neuropeptides (although this does occur). In the context of the OT system, it would allow the OT ligand and the OT receptor to remain conserved molecularly while influencing behavioral variation through more or less expression of the OT ligand and OT receptor, as a consequence of more or less transcription of the OT and OTR gene in specific regions of the brain.

Studies that have examined the OTR gene in non-primate animals have shown that the OTR gene does contain many functional TFBSs (Bale & Dorsa, 1998; Blanks, Shmygol, & Thornton, 2007; Gimpl & Fahrenholz, 2001). Research on

regulation of the OTR gene has primarily been conducted using nonhuman animal models (Gimpl & Fahrenholz, 2001), although regulation of the OTR gene in the human uterus has also been studied (Blanks et al., 2007).

Noncoding regions, specifically the 5' flanking region (approximately 5,000 base pairs (bp) upstream of the start codon), of the OTR gene have also been implicated in regulation of OTR expression (Fields & Gainer, 2015; Young et al., 1997). Although the exact mechanisms underlying this regulation are still being investigated, data suggest that region-specific gene expression of OTR is controlled by TFBSs generally located in the 5' flanking region of the gene (Young et al., 1997). Recent research comparing the 5' flanking region across primates found that the 5' flanking region was the least conserved region in the study (Babb, Fernandez-Duque, & Schurr, 2015). The 5' flanking region for the two socially monogamous primates examined (owl monkeys and gibbons) exhibited substantial differences, suggesting that monogamy has arisen multiple times in the primate order through different molecular mechanisms (Babb et al., 2015). Surprisingly, the study also revealed that no specific kind of genetic variation clustered with any particular social systems exhibited by primate taxa (Babb et al., 2015).

Virtually all of the studies on humans and the OTR gene have focused primarily on single nucleotide polymorphisms (SNPs) in noncoding regions (for review see Kumsta & Heinrichs, 2013). Usually, these types of studies are characterized by two possible alleles at a given locus being tested for correlations to social behavior or brain morphology. The loci are identified as individual reference SNP clusters, the most studied in the OTR gene being rs53576 and rs2254298. The SNP rs53576 has been linked to hypothalamic and amygdala volume (Tost et al., 2010, but see Inoue et al. (2010), sensitive parenting (Bakermans-Kranenburg & van IJzendoorn, 2008), empathy (Rodrigues, Saslow, Garcia, John, & Keltner, 2009), dopamine function (Chang et al., 2014), vulnerability to stress (Saphire-Bernstein, Way, Kim, Sherman, & Taylor, 2011), depression (Bradley et al., 2011; McQuaid, McInnis, Stead, Matheson, & Anisman, 2013), and loneliness (Lucht et al., 2009). SNP rs2254298 is associated with gray matter, amygdala, anterior cingulate cortex, and brainstem volume (Furman, Chen, & Gotlib, 2011; Inoue et al., 2010), autism (Jacob et al., 2007; Wu et al., 2005), attachment (Chen et al., 2011), and plasma OT levels (Feldman et al., 2012). These two SNPs are among the hundreds, if not thousands, identified across the entire OTR gene, as well as within the third intron.

The human OTR gene, like the OT gene, contains TFBSs in the 5' flanking region of the gene, including a partial estrogen response element (ERE). An ERE is a TFBS in a gene, where estrogen that is bound to an estrogen receptor can bind to and induce transcription of the gene (Gimpl & Fahrenholz, 2001). Although it is unclear if the OTR gene is primarily regulated by estrogen, there does seem to be evidence that it is at least partially so (Gimpl & Fahrenholz, 2001). OT is best known for its role in regulating birth and lactation, and along with AVP, it has also been found to play a central role in maternal care and attachment (Carter, 2002; Curtis & Wang, 2003; Heinrichs, Dawans, & Domes, 2009; Heinrichs & Domes, 2008; Lee et al., 2009; Lim, Murphy, & Young, 2004; Seltzer, Ziegler, & Pollak, 2010;

Young, Wang, & Insel, 2002), with dopamine, cortisol, and other hormones and neurotransmitters having mediating effects. Just prior to birth, an increase in OT occurs, which is seen as priming maternal care. An injection of OT to virgin rats has been found to induce maternal care, while an OT antagonist administered to pregnant rats interferes with the development of maternal care (Carter, 2002). Among mammals, hormonal activation initially stimulates maternal behavior among new mothers. Once she has begun to care for her offspring, however, hormones are not required for maternal behavior to continue. Olfactory and somatosensory stimulation from interactions between offspring and mother is, however, usually required for the parental care to continue (e.g., Fleming, O'Day, & Kraemer, 1999).

fMRI studies in humans indicate that the reward system, which contains a high density of receptors for OT and AVP in more social mammals, is critical for maternal attachment (Bartels & Zeki, 2004; Fisher et al., 2006). In one study, peripheral OT levels were measured during mother-infant interactions (but not at the time of the fMRI scan); researchers investigated the role of mother-infant attachment as a modulator of BOLD response and OT levels as well as looking at OT levels as a predictor of BOLD responses to infant stimuli (Strathearn, Fonagy, Amico, & Montague, 2009). For attachment, they classified mothers as Type A "Insecure/Dismissing," Type B "Secure," and Type C "Insecure/Preoccupied," although they did not use Type C for most analyses (Strathearn et al., 2009). During the scan, each mother viewed 60 unique infant face images, 30 of her own infant and 30 of the matched unknown infant face (Strathearn et al., 2009). When comparing Type A mothers to Type B mothers, they found that Type B mothers had greater activity in the prefrontal cortex (PFC) (including the lateral, medial, and orbitofrontal regions of the PFC), the ventral striatum (which contains the NAcc, a dopaminergic reward region), and the hypothalamus/pituitary than Type A mothers (Strathearn et al., 2009). This indicates that OT may be more likely to be released from the hypothalamus into the PNS (via the pituitary) as well as into the CNS, impacting cortical regions and reward regions, in securely attached mothers, implicating OT in mother-infant relationships. This is supported by a high correlation between activation in the ventral striatum in response to own infant's neutral face and peripheral oxytocin response; this occurred across attachment types and was not observed with unknown infant faces (Strathearn et al., 2009). Many of these same regions are activated in response to infant cries (see Table 4.4) (Swain et al., 2014). Overall, Type B mothers had significantly higher peripheral oxytocin levels after periods of mother-infant interaction, even though there were no differences between attachment groups in basal OT levels (Strathearn et al., 2009).

In a review of the fMRI literature on parents' BOLD responses to infant cries (Swain et al., 2014), both mothers and fathers (two weeks postpartum) showed activity in areas of the midbrain, basal ganglia, cingulate, amygdala, and insula (Swain et al., 2014). Higher activity in these regions is only apparent for two to four weeks postpartum, and at three to four months postpartum activity is no longer higher in these regions; instead, the PFC and hypothalamus become more active in both mothers and fathers during this period (Swain et al., 2014). The researchers speculate

Table 4.4 Brain regions with increases in BOLD responses following OT-inducing stimuli

Region	Infant faces	Infant cries	Orgasm
Hypothalamus	Y	Y	Y
Insular cortex	Y	Y	Y
Medial amygdala	–	Y	Y
Anterior cingulate cortex	–	Y	Y
Posterior cingulate cortex	–	Y	–
Nucleus accumbens	Y	Y	Y
Caudate/putamen	Y	Y	–
Cerebellum	–	–	Y
Hippocampus	–	–	Y
Frontal/medial prefrontal cortex	Y	Y	Y
Parietal cortex	–	–	Y
Thalamus	Y	Y	–
Ventral tegmental area/midbrain	Y	Y	–
Septal nuclei	–	Y	–
Orbitofrontal cortex	Y	Y	–
Temporal cortex	–	Y	–
Fusiform gyrus	–	Y	–
Substantia nigra	Y	–	–
Superior temporal gyrus	Y	–	–
Pre- and postcentral gyri	Y	–	–

that this shift may reflect changes in parenting confidence or experience and greater cortical regulation of alarm and anxiety related regions, such as the amygdala and insula (Swain et al., 2014). Additionally, mothers' responses at two to four weeks postpartum were greater than fathers' in the basal ganglia and amygdala, suggesting more arousal and anxiety in mothers than fathers (Swain et al., 2014). There were also activation differences at two to four weeks postpartum between women who had given birth vaginally and those who had given birth via cesarean section, with mothers who had given birth vaginally having greater responses in the caudate, thalamus, hypothalamus, amygdala, and pons after exposure to their own infants' cries; however, these differences between groups were no longer significant after scanning again at three to four months postpartum (Swain et al., 2014). There were similar differences between mothers who were breastfeeding compared to those who were using formula to feed their infants at the time of the scan, with greater activity in the anterior and posterior cingulate, thalamus, midbrain, hypothalamus, striatum, PFC, temporal cortex, fusiform gyrus, amygdala, and septal nuclei (Swain et al., 2014).

As stated, the septal nuclei, previously identified as containing OTRs in humans across multiple methods, also showed greater activity following exposure to infant cries in breastfeeding (as compared to non-breastfeeding) mothers (Swain et al., 2014). The septal nuclei have been implicated in the maintenance of emotional behavior, sexual behavior, aggressive behavior, and attention and memory functions (Felten, O'Banion, & Maida, 2016).

In humans, damage to these nuclei can result in “rage behavior,” and in rodents, lesions result in “sham rage” (“exaggerated reactivity to both appropriate and innocuous stimuli”) (Felten et al., 2016). However, when implanted with electrodes that can be self-stimulated, rodents will show prolonged and repeated self stimulation, which may imply a reward-processing component to the septal nuclei as well (Felten et al., 2016). It has also been suggested that these nuclei play a role in memory (Felten et al., 2016). Taken together, these data suggest that the septal nuclei may play a role in attachment and bonding by reducing or suppressing aggressive impulses, increasing experience of reward during interactions, and then facilitating memory of the interaction. Interestingly, this is the only area identified across OTR localization and fMRI studies that has been shown to have differential expression between humans and rats, with humans expressing far more OTRs in the region than rats (see Table 4.2). As such, this area may represent a region of interest for elucidating the evolution of the oxytocin system in humans, particularly as it relates to human attachment and bonding.

The mother-offspring relationship is at the core of mammalian life, and it appears that some of the biochemistry at play in the regulation of this intimate bond was also selected to serve in primary mechanisms regulating bonds between mates, paternal care, the family group, and even larger social networks (Fisher et al., 2006; Hrdy, 1999; Wynne-Edwards, 2001). It will be interesting to see what further fMRI studies of attachment in human males indicate because that is where the most substantial differences from other mammals would be expected. Similarly, fMRI studies of attachment to mothers, fathers, and alloparental care providers in human children may provide important insights into the other side of parent-offspring bonding.

Paternal care

Paternal care is not common among mammals (Clutton-Brock, 1991). For evolutionary reasons noted earlier, it is found among some rodent and primate species, including humans. The extent and types of paternal care vary among species. The hormonal influence in parental care among males appears to differ somewhat from that found among females. AVP appears to be more important for male attachment and bonding (Young et al., 2002). For example, along with prolactin and OT, AVP prepares the male to be receptive to and care for infants (Bales, Kim, Lewis-Reese, & Carter, 2004). Paternal care is more common in monogamous than polygamous mammals and is often related to hormonal and behavioral stimuli from the female. In the monogamous California mouse, disruption of the pair-bond does not affect maternal care but does diminish paternal care (Gubernick, 1996). In some other

species with biparental care, however, paternal care is not as dependent on the presence of the female (Young et al., 2002). Experience also plays a role in influencing hormonal activation and paternal behavior. Among tamarins, experienced fathers have higher levels of prolactin than first-time fathers (Ziegler & Snowdon, 1997).

Androgens including testosterone also appear to be involved in the regulation of paternal behavior. For example, human fathers tend to have lower testosterone levels when they are involved in childcare activities (Berg & Wynne-Edwards, 2002; Fleming et al., 2002; Gray & Campbell, 2009; Kuzawa et al., 2009), although the relation with the key paternal role of offspring protection is uncertain. Human males stand out as very different from our closest relatives, the chimpanzees, in the areas of paternal attachment and investment in offspring. Investigation of the neuroendocrine mechanisms that underpin male parental behavior may provide important insights into these critical evolutionary changes.

Like male parental care, bonding between mates is also uncommon among mammals but has been selected for when it has reproductive advantages for both parents (Carter, 2002; Clutton-Brock, 1991; Young et al., 2002). Monogamy is found across many mammalian taxa, but most of the current knowledge related to the neuroendocrine basis of this phenomenon has been obtained from the comparative study of two closely related rodent species. As previously mentioned, the prairie vole mating pair nest together and provide prolonged biparental care, while their close relatives, the meadow vole (*Microtus pennsylvanicus*), do not exhibit these behaviors (Young et al., 2002). As with other social behaviors in rodents, OT and AVP have been found to be central in the differences these related species exhibit with respect to pair-bonding. Pair-bonding occurs for the prairie vole following mating. Vagino-cervical stimulation results in a release of OT and the development of a partner preference for the female (Carter, 2002). For the male, it is an increase in AVP following mating and not just OT that results in partner preference. Exogenous OT injected in the female and exogenous AVP in the male prairie vole result in mate preference even without mating. This does not occur with meadow voles (Young et al., 2002).

Similarly, in humans OT is released during orgasm, which may strengthen pair-bonds (Gimpl & Fahrenholz, 2001). Using a very small sample of women ($n = 5$) diagnosed with complete spinal cord injury, Komisaruk et al. (2004) tested which pathways were responsible for vaginal-cervical perceptual awareness using fMRI. While imaging the brain and spinal cord, women were instructed to apply vaginal-cervical self-stimulation for 28 seconds ON and 32 seconds OFF for 8 or 12 successive cycles, which was repeated again after approximately 30 minutes (Komisaruk et al., 2004, p. 79). Three of the five women experienced orgasm during the scan; this was associated with significantly higher activity overall than during cervical self-stimulation prior to orgasm, particularly in the hypothalamus (specifically the PVN), insular cortex, medial amygdala, anterior cingulate cortex, nucleus accumbens, cerebellum, hippocampus, frontal cortex, and parietal cortex (Komisaruk et al., 2004). These areas have been implicated in OTergic activity in other studies, suggesting a role for OT in the establishment and maintenance of pair-bonds; Table 4.4 shows regions of overlap between infant stimuli and orgasm.

As mentioned, the receptor density for OT and AVP in specific brain regions might provide the basis for mechanisms underlying other social behaviors. Other neurotransmitters, hormones, and social cues also are likely to be involved, but slight changes in gene expression for receptor density, such as those found between the meadow/montane and prairie voles in the ventral pallidum (located near the nucleus accumbens, an important component of the brain's reward system), might demonstrate how such mechanisms could be modified by selection (Lim et al., 2004). The dopamine D2 receptors in the nucleus accumbens appear to link the affiliative OT and AVP pair-bonding mechanisms with positive rewarding mental states (Aragona et al., 2005; Curtis & Wang, 2003). The combination results in the powerful addiction that parents have for their offspring.

Given the adaptive value of extensive biparental care and prolonged attachment found in the mating pair and larger family network, it is not surprising that similar neurohormonal mechanisms active in the maternal-offspring bond would also be selected to underlie these other attachments. Though there is some variation among species and between males and females, the same general neurohormonal systems active in pair-bonding in other species are found in the human (Lee et al., 2009; Panksepp, 2004; Wynne-Edwards, 2003). Androgen response to pair-bonding appears complex (e.g., van der Meij, Buunk, van de Sande, & Salvador, 2008), but similar to parent-offspring attachment in that pair-bonded males tend to have lower testosterone levels in non-challenging conditions (Alvergne, Faurie, & Raymond, 2009; Gray & Campbell, 2009). Moreover, males actively involved in caretaking behavior appear to have temporarily diminished testosterone levels (Gray, Parkin, & Samms-Vaughan, 2007).

Hormonal mechanisms for another key human adaptation, bonding among adult males forming coalitions – “bands of brothers” – is less well studied. Social effects such as victories against outsiders produce elevations in testosterone, but defeating friends does not (Flinn, Ponzi, & Muehlenbein, 2012; Fuxjager, Mast, Becker, & Marler, 2009; Gleason, Fuxjager, Oyegbile, & Marler, 2009). Human males, moreover, may differentially respond to females contingent on whether the females are in a stable breeding bond with a close friend; males have lower testosterone after interacting with wives of their relatives and friends (Flinn et al., 2012). Involvement of the affiliative neuropeptides (OT and AVP) in relationships among adult males is unknown.

The challenge before human evolutionary biologists and psychologists is to understand how these general neuroendocrine systems have been modified and linked with other special human cognitive systems (e.g., Allman, Hakeem, Erwin, Nimchinsky, & Hof, 2001; Blakemore, Winston, & Frith, 2004; Ulrich-Lai & Herman, 2010) to produce the unique suite of human family behaviors. Analysis of hormonal responses to social stimuli may provide important insights into the selective pressures that guided the evolution of these key aspects of the human mind. Similarly, phylogenetic analyses of the affiliative neuropeptide genes (i.e., those that code for OT, OTRs, AVP, and the AVP receptor subtypes) across primates, including early humans through the use of ancient DNA, may provide critical insight into the evolution of bonding, attachment, and family/social structure during human evolutionary history.

Summary and concluding remarks

Human childhood is a life history stage that appears necessary and useful for acquiring the information and practice to build and refine the mental algorithms critical for negotiating the social coalitions that are key to success in our species (Del Giudice, Angeleri, & Manera, 2009). Mastering the social environment presents special challenges for the human child. Social competence is difficult because the target is constantly changing and similarly equipped with theory of mind and other cognitive abilities. Here we suggest that family environment, including care from fathers and grandparents, is a primary source and mediator of the ontogeny of social competencies.

Social competence is developmentally expensive in time, instruction, and parental care. Costs are not equally justified for all expected adult environments. The human family may help children adjust development in response to environmental exigencies for appropriate tradeoffs in life history strategies. An evolutionary developmental perspective of the family can be useful in these efforts to understand this critical aspect of a child's world by integrating knowledge of physiological causes with the logic of adaptive design by natural selection. Human biology has been profoundly affected by our evolutionary history as unusually social creatures, including, perhaps, a special reliance upon cooperative fathers, grandparents, and kin residing in other groups. Indeed, the mind of the human child may have design features that enable its development as a group project, guided by the multitudinous informational contributions of its ancestors and co-descendants.

Understanding the co-evolution of the core human adaptations of stable breeding bonds, biparental care, altricial infancy, prolonged childhood, complex social intelligence, extended kinship networks, and intergroup alliances presents difficult challenges for evolutionary anthropology and archaeology. The inclusion of ideas and methods from the life sciences may prove helpful by elucidating the evolution of the mechanisms underlying these behaviors.

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5

THE EVOLUTION AND DEVELOPMENT OF MORALITY

Dennis L. Krebs

At one time or another, virtually everyone has wondered how people become moral. To answer this question, we must specify what it means to be moral (the dependent variable) and identify the processes (the independent variables) that produce this effect. Over the centuries, philosophers of ethics have argued vigorously about the meaning of morality, devoting their efforts mainly to debating the merits of ultimate principles such as “treat people as ends, not as means,” and “act in ways that produce the greatest good for the greatest number.” As brilliant as such arguments may be, they have not produced a consensus about the nature of morality. In contrast to philosophers, scientists who have advanced accounts of how people become moral have attended mainly to the independent variables they have viewed as the most important sources, assessing their effects on measures of morality that fit best with their theories. This practice has led scientists from different schools of thought to assume that they are offering competing explanations for the same phenomena when, in fact, they are attending to quite different things.

Psychologists have interpreted the question of how people become moral mainly as a question about human development: What causes infants who are amoral or immoral at birth to grow into moral adults? In contrast, biologists and anthropologists have interpreted it mainly as a question about biological evolution: How did moral traits evolve in the human species? In this chapter, I will argue that the key to understanding what morality is and how people become moral lies in understanding how it originated and the adaptive functions that moral traits evolved to serve. I will begin by reviewing the main psychological theories of how children become moral, identify some of their limitations, go on to advance an account of how moral traits evolved in the human species, then explain how this evolutionary account can help us refine and expand psychological theories and direct us toward a valid definition of morality.

Psychological approaches to morality

Psychological accounts of morality parade under three main banners – social learning theory, cognitive-developmental theory, and dual-process theory. I will consider each in turn.

Social learning accounts

The central assumption of social learning accounts of morality is that children learn to be moral from others – by internalizing the moral ideas others preach, by following others' examples, and by modifying their behaviors in accordance with the rewards and punishments that others administer (Bandura, 1989). Social learning theorists define morality primarily in terms of conformity to the moral norms of societies.

Clearly, there is a great deal of merit in social learning accounts of morality. Parents teach children the difference between right and wrong; children (and adults) imitate the moral behaviors of models; and people learn to behave themselves in order to obtain rewards and to avoid punishments from others, especially in the form of approval and disapproval. However, social learning accounts of the acquisition of morality are limited in at least four ways. First, they do not begin at the beginning. Although they may begin at the beginning of children's lives, they fail to explain how the moral ideas and behaviors that adults have transmitted to children over the generations originated in the first place. Second, social learning accounts of morality portray children (and adults) as relatively passive recipients of moral ideas that are poured or stamped into them by others; however, we know that children often challenge adults, argue with them, and reject ideas that they do not like. Relations between children and adults involve conflicts, and a substantial portion of their social energy is devoted to the resolution of conflicts. Children also are selective about the people they imitate and the forms of conduct they copy.

Third, the similarities between the moral knowledge possessed by adults and the moral knowledge possessed by children may be more apparent than real, because even when young children parrot things that their parents and other adults say, they often conceptualize them differently. In particular, young children's conceptions of morality tend to be less sophisticated than those of their parents and other adults. Finally, social learning accounts of the acquisition of morality fail to answer important why questions. Why do parents (and others) preach moral ideas to children? Why do people accept some of the ideas that others preach to them, but reject others? Why are people selective about the behaviors they copy?

Kohlberg's cognitive-developmental account

The cognitive-developmental account of how people become moral advanced by Lawrence Kohlberg (1984) became regnant in the second half of the twentieth century. In contrast to social learning theorists who defined morality mainly in terms

of the internalization of moral norms, Kohlberg defined morality mainly in terms of the structure of moral reasoning, arguing that children and adults develop their conceptions of morality by figuring out solutions to moral problems. Kohlberg asserted that the process of thinking about morality and making moral decisions induces children and adults to develop increasingly sophisticated mental mechanisms for processing moral information and deriving moral judgments, which he called structures of moral reasoning. Kohlberg argued that these “structures of the whole” guide all of a person’s moral decision-making, and that they normally undergo several qualitative transformations as people develop, giving rise to up to six stages of moral development.

The primary evidence that Kohlberg and his colleagues adduced to support their account of moral development stemmed from a 20-year longitudinal study employing hypothetical moral dilemmas such as one involving a character named Heinz who faces a choice between stealing a drug or letting his wife die from cancer. Participants in Kohlberg’s longitudinal study (all males) were required to say what the main characters in Kohlberg’s moral dilemmas should do, then to justify their choices. Kohlberg and his colleagues offered persuasive evidence that as these participants grew older, they conceptualized the moral issues in the dilemmas in qualitatively different ways. Participants gave a relatively unsophisticated set of justifications for their decisions when they were young, then increasingly sophisticated sets of justifications as they got older.

Clearly, there is considerable merit in Kohlberg’s assertion that there is more to morality than the passive internalization of parental injunctions and social norms. In support of Kohlberg’s theory, we know that people sometimes play an active role in developing their own moral knowledge, and people tend to become increasingly knowledgeable as they develop. We know from experience that children think about moral issues in simpler and less rational ways than most adults do. “Stage 2” moral principles espoused by young children, such as “get even with those who wrong you,” seem less sophisticated (and therefore, in Kohlberg’s view, less moral) than “Stage 3” principles espoused by older children, such as “do unto others as you would have them do unto you.” We also know from experience that people sometimes reflect on moral problems, deliberate about them, and try to figure out the most moral solutions, playing the role of amateur philosophers of ethics, viewing moral problems from the perspective of all people involved, considering the claims of interested parties, and figuring out how to resolve conflicts of interest in impartial ways. And we know that people also sometimes attempt to deduce moral decisions from general principles such as the Golden Rule.

The merits of Kohlberg’s approach notwithstanding, however, research evaluating it has revealed that it is limited in at least five ways: (1) people may invoke different forms of moral reasoning to solve different kinds of moral problems, (2) the post hoc types of justifications people offer to support their choices on moral dilemmas may not mirror the a priori types of moral reasoning they engage in to derive their decisions, (3) contextual factors and emotional reactions may

affect moral reasoning, (4) people may make real-life moral judgments in different ways from how they make hypothetical moral judgments, and (5) people may not behave in accordance with their moral judgments (see Krebs & Denton, 2005, for a review of relevant research). Let us consider each of these limitations in turn.

The flexibility of moral reasoning

Most of the evidence supporting Kohlberg's theory of moral development was derived from people's justifications for moral decisions they made about the hypothetical moral dilemmas on Kohlberg's test obtained in academic settings in response to why questions. The problem is, the dilemmas on Kohlberg's test are not representative of the kinds of moral dilemmas that people customarily encounter. Indeed, Kohlberg's dilemmas and the probes made by interviewers were explicitly designed to induce people to invoke the most sophisticated forms of moral reasoning available to them – to display their moral competence; to do their best thinking. Research by other investigators revealed that people often perform below their level of competence, invoking less sophisticated (lower stage) forms of moral reasoning in response to other kinds of moral dilemmas (see Krebs & Denton, 2005, for a review of this research). For example, studies found that participants who make relatively advanced (Stage 4) society-upholding moral judgments on Kohlberg's test made more care-oriented (Stage 3) judgments about dilemmas involving interpersonal conflicts and helping someone in need (Krebs, Denton, Vermeulen, Carpendale, & Bush, 1991), and more instrumental (Stage 2) judgments about dilemmas involving business transactions (Carpendale & Krebs, 1992) and driving after drinking (Denton & Krebs, 1990). Findings such as these are inconsistent with Kohlberg's contentions that people think about all moral problems in the same overriding way and that people are "in" particular stages of moral development, defined by the sophistication of their moral reasoning. Rather, such findings demonstrate that people are inclined to invoke different forms of moral reasoning to solve different kinds of moral problems.

A priori reasoning vs. ad hoc justifications

Cognitive-developmental theorists assume that the types of moral reasoning that people display to justify their moral decisions in response to interviewers' why probes reflect their original reasons for making the decisions. It is, however, quite possible that people derive their moral decisions in one way, from one source, and justify them in another (more sophisticated) way (Haidt, 2001). The ethical ideas that people invoke to justify the hypothetical moral decisions they make in response to Kohlbergian dilemmas may be the product of an intellectual exercise that bears no more relation to the ways in which people actually make moral decisions than the musings of philosophers of ethics bear on their decisions to engage in extramarital affairs or to donate to charity.

Contextual factors and psychological states

Investigators have found that social contexts and psychological states may affect the types of moral reasoning that people display. For example, Carpendale and Krebs (1992) found that university students engaged in less sophisticated forms of moral reasoning when they believed they were addressing a businessperson than they did when they believed they were addressing a philosopher of ethics, and Denton and Krebs (1990) found that university students engaged in more immature forms of moral reasoning when they were drinking at bars and parties than they did in academic contexts. Other studies found that people's emotional reactions affect the forms of moral reasoning they display (Haidt, 2001; Krebs & Denton, 2005).

Hypothetical vs. real-life moral reasoning

When it comes down to it, few people base their attributions of morality on how others respond to hypothetical moral dilemmas; they base them on how others make moral decisions in their everyday lives, and researchers have found significant differences between hypothetical moral reasoning and real-life moral reasoning (Krebs, Denton, & Wark, 1997). When people make real-life moral decisions, they usually invoke less advanced forms of moral reasoning than they display when responding to Kohlberg's hypothetical dilemmas. If given complex moral dilemmas, people usually will rise to the occasion and display the most sophisticated forms of moral reasoning available to them. However, people also may invoke quite simple forms of moral reasoning when they are faced with familiar moral dilemmas, and people often make moral decisions without thinking much about the issues in question or engaging in extended bouts of rational deliberation (Haidt, 2001).

It is worth noting that the moral judgments that people make in response to hypothetical dilemmas like the ones on Kohlberg's Moral Judgment Interview are third-person moral judgments about others (e.g., "*Heinz* should steal the drug to save *his* wife"). However, when people make moral judgments in their everyday lives, they also make second-person judgments about others (e.g., "*You* should not have cheated on me") and first-person judgments about themselves (e.g., "*I* should not have lied to you"). Researchers have found that the real-life moral judgments that people made about themselves differ in significant ways from the real-life judgments they made about others (Krebs et al., 2002; Krebs & Laird, 1998). Following a review of relevant studies, MacDonald (1988) concluded that "reasoning about oneself, one's relatives, and significant others is done with a different calculus than is reasoning about hypothetical situations" (p. 148). In other words, people's moral judgments tend to be biased in self-serving ways.

Moral reasoning vs. moral behavior

Kohlberg's account of moral development and his definition of morality are based on moral *reasoning*, but how people think about morality is less important to the average person than what people do. What good is moral reasoning if people do not

use it to guide their conduct? Kohlberg argued that moral reasoning is a necessary condition for moral behavior, because in order to qualify as moral, an act must stem from moral reasoning. In addition, Kohlberg argued that more advanced forms of moral reasoning instill stronger motives to behave in accordance with the decisions they produce than less advanced forms do, causing him to predict a positive relation between the sophistication of moral reasoning producing a moral decision (i.e., stage of moral development) and the likelihood that the person deriving the decision would behave in accordance with it.

However, a spate of research failed to reveal a strong or consistent relation between moral reasoning and moral behavior. For example, when two of Kohlberg's closest colleagues – Colby and Damon (1992) – gave a group of “moral exemplars” Kohlberg's test, they found that most of these exemplars displayed only moderately sophisticated (Stage 3 and 4) forms of moral reasoning. People such as Mother Theresa do not present as moral because they are able to solve complex moral problems, but rather because they devote their lives to helping others.

To be fair, Kohlberg came to acknowledge that although moral reasoning was necessary for moral behavior, it might not be sufficient, and that qualities such as ego-strength may be necessary to bridge the gap. However, other researchers found that simple forms of moral reasoning were plenty enough to induce people to behave in ways that virtually everyone would consider moral, and that people who displayed the ability to engage in very sophisticated forms of moral reasoning on Kohlberg's test (and therefore were considered to be at high stages of moral development) did not necessarily behave any more morally than those who displayed less advanced forms (though those who displayed very immature forms were prone to behave in immoral ways) (see Krebs & Denton, 2005, 2006, for a review of this research). In addition, investigators found that the causal relation between moral reasoning and moral behavior may work in both directions. In some contexts, people invest considerable energy figuring out what they ought to do, then act on their decisions, but in other contexts, people seem to act first, then engage in moral reasoning to justify their decisions (Haidt, 2001). MacDonald (1988) concluded that “individuals who are adept at moral reasoning (i.e., who perform at the higher stages) are better able to provide reasons which rationalize their self-interested actions in a manner that would justify their behavior to other individuals” (p. 148).

Dual-process theories of moral decision-making

Although Kohlberg and his colleagues demonstrated that people sometimes think hard about moral dilemmas and derive moral decisions in rational ways, other researchers found that people also make moral decisions in relatively automatic, impulsive, mindless, and intuitive ways (and if challenged, appeal to reason to justify them) (Haidt, 2003). Dual-process theorists account for the apparent inconsistency between rational and intuitive accounts of moral decision-making by adducing evidence that people possess two decision-making systems, which have been labeled

“Type 1” and “Type 2.” Type 1 decision-making has been characterized as emotional, intuitive, unconscious, automatic, fast, frugal, contextualized, and domain specific. Type 2 decision-making has been characterized as rational, reflective, deliberative, conscious, slow, controlled, effortful, abstract, domain general, rule-based, and logical (Evans, 2008). Type 2 decision-making is positively related to cognitive ability, but Type 1 decision-making is not.

Dual-process theorists have assessed people’s brain activity as they make moral decisions and found that when people respond to some kinds of dilemmas, areas in their brains known to mediate rational controlled Type 2 decision-making become active, whereas when they respond to other kinds of dilemmas, areas in their brains known to mediate emotional automatic Type 1 decision-making become active. Investigators have struggled to explain this difference. The neuroscientist Damasio (1994) cast some light on this issue when he found that although patients with damage to the structures in their brains that mediate emotional decision-making performed well on reasoning tests, they made poor moral decisions in their everyday lives, failing to abide by moral norms and behaving in selfish, irresponsible, and deviant ways. Damasio concluded that although patients afflicted with such brain injuries *understood* the difference between right and wrong – they did not suffer a deficit in their ability to derive moral judgments in rational (Type 2) ways (and probably would have performed well on Kohlberg’s test of moral reasoning) – they did not *feel* the difference because they did not experience moral emotions in the same way that normal people do.

Evidence that most people are able to make moral decisions in at least two ways raises several challenging questions. Why do people possess at least two moral decision-making systems? Why isn’t one enough? What causes people to make decisions in quick and automatic ways in some conditions and in deliberate and controlled ways in other conditions? Indeed, logically prior to these questions, it is appropriate to ask why people are motivated to make moral decisions at all. Why do people care about morality? I believe that the key to answering these questions lies in viewing the mental mechanisms that produce different forms of moral judgment as structures designed to solve problems in the most effective manner. It is as though people acquire or develop a chest of mental tools, or abilities, and when faced with a particular moral problem, they select the tool best equipped to solve it.

To understand why people derive moral judgments in one way and not another, and to explain why people make different kinds of moral judgments, we need to identify the goals that these tools were designed to achieve. Attending to the goals that people use moral judgments and moral behaviors to achieve entails attending to the functions of morality. What use is morality? What is it for? As expressed by Krebs (2011), “if we keep pushing back to increasingly ultimate motives, goals, and functions, we inevitably end up either in some ephemeral determining force, such as God, or in ultimate goals such as surviving and reproducing, which lands us squarely in the theory of evolution” (p. 7).

An evolutionary approach to morality

Evolutionary theorists ask how moral traits evolved in the human species, and why. Most (but not all) of the traits we inherit evolved because they were adaptive – that is to say, because they helped early humans achieve the ultimate goals of surviving, reproducing, and propagating their genes. (There are several ways in which maladaptive moral traits could evolve, but I will focus on adaptive moral traits in this chapter.) Evolutionary theory leads us to hypothesize that members of early human groups who inherited genes that (in interaction with environmental inputs) endowed them with moral traits passed more replicas of these genes on to future generations than individuals who did not inherit such genes, causing an increase in the number of individuals in the population possessing moral traits until, eventually, moral traits became part of human nature. Viewed in this way, the key to understanding how we became moral lies in figuring out how moral traits helped early humans survive, reproduce, and propagate their genes. To accomplish this, we must identify the biological purposes that moral traits served. What kinds of adaptive problems did they help our early human ancestors solve?

The problem of cooperation

Along with many other theorists, I believe that the primary function served by moral traits was to help early humans reap the biological benefits of sociality and cooperation. In contrast to solitary animals that are well equipped to survive on their own, early humans solved their adaptive problems by joining forces with others. Our ancestors increased their ability to defend themselves against predators and enemies, to hunt large game, to build shelters, to survive in times of scarcity, to mate, and to rear their offspring by banding together and engaging in cooperative exchanges.

In view of the obvious biological benefits of cooperation, it might seem that it would be easy for adaptations that induce animals to cooperate to evolve, but this is not the case because it is in the biological interest of the parties involved in cooperative tasks or exchanges to minimize their costs and to maximize their gains, which creates the temptation to cheat. For example, it is in the interest of animals that practice group hunting to conserve their energy, position themselves in ways that diminish their chances of getting injured while at the same time maximizing their share of the kill. In a similar vein, it is in the interest of animals that band together to protect themselves against predators to minimize their risks by, for example, jostling for center positions to avoid being picked off at the periphery. In the currency of evolution, we would expect selfish individuals competing against cooperative individuals to propagate more offspring, and for these selfish offspring to propagate more selfish offspring, and so on, causing an exponential explosion of selfish individuals within cooperative groups. Even more problematically, if all members of a group were selfish to begin with (which many assume was the original state), it is difficult to see how cooperative traits could have gotten a foothold in the first place.

It might seem to follow that on the laws of evolution all species must be selfish by nature, as some evolutionary theorists have claimed (Williams, 1989). However, there is a problem with this conclusion because selfish strategies are not optimal in species that need assistance from others to solve their adaptive problems. Although selfish individuals may prevail in interactions with cooperative individuals, they fare poorly in interactions with other selfish individuals. In the extreme, if selfish individuals completely flooded a previously cooperative group, they could “win” themselves out of existence because they would end being forced to interact with one another, with no cooperators to exploit.

Thus, the evolution of cooperation presents a conundrum. Individuals who inherit genes that dispose them to cooperate tend to fare better when they interact with other cooperative individuals than individuals who inherit genes that dispose them to behave selfishly do when they interact with other selfish individuals, so two or more cooperators are able to advance their biological interests better than two or more selfish individuals are. Cooperative groups also tend to prevail in competitions against selfish groups – an outcome that some theorists believe was critical in the evolution of morality (Richerson et al., 2016). However, within mixed groups, selfish members are able to exploit cooperative members; yet if they are successful enough to permeate the group, they end up destroying the resources (i.e., the cooperators) on which they preyed.

The adaptive functions of moral traits

Moral traits evolved to help early humans solve the problems of selfishness that prevented them from reaping the long-term biological benefits of cooperating with members of their groups. As asserted by Curry (2016), humans have descended from “a long line of social primates; they have spent 50 million years living in social groups . . . and two million years making a living as intensely collaborative hunter-gatherers.” Because of this, they have acquired “a range of biological – including psychological – adaptations for cooperation . . . [and] it is precisely these mechanisms – these solutions to problems of cooperation, this collection of instincts, intuitions, ideas, and institutions that constitute human morality” (p. 29).

To solve the problems of cooperation, members of groups must find mutually beneficial ways of resolving their conflicts of interest. According to the evolutionary biologist Richard Alexander (1987), “agreement seems to be universal . . . that moral (and ethical) questions and problems arise because of conflicts of interest; I have never found an author who disagrees. If there were not conflicts of interest among people and societies it is difficult to see how concepts of right and wrong, ethics and morality, and selfishness and altruism could ever have arisen” (p. 3). Alexander argues that to understand conflicts of interest fully, we must trace them back to their biological core: “The interests of every individual human (i.e., the directions of its striving) are expected to be toward ensuring the indefinite survival of its genes and their copies, whether these are resident in the individual, its descendants, or its collateral relatives” (p. 3).

Moral traits evolved because they helped early humans resolve their conflicts of interest in ways that enabled them to reap the benefits of cooperation. Moral emotions such as love, empathy, sympathy, guilt, gratitude, forgiveness, and righteous indignation evolved because they motivated individuals to cooperate with other members of their groups. Moral judgments evolved to persuade others to behave in cooperative ways. Moral knowledge evolved to help people understand optimal forms of cooperation. Conscience evolved to induce individuals to resist the temptation to behave selfishly and cheat. Moral behaviors such as those that involve self-control, helping others, treating others fairly, paying others back, behaving in courageous ways, obeying rules, practicing honesty, and being loyal to members of one's group evolved because they upheld biologically beneficial systems of cooperation.

Reframing psychological accounts of morality

One of the most valuable features of the theory of evolution is that it supplies an overriding framework for organizing, refining, and expanding the insights from psychological accounts, resolving their inconsistencies, and increasing their explanatory power. Viewing the jigsaw puzzle of morality from an evolutionary perspective enables us to assemble the pieces produced by psychologists, put them together in coherent ways, and, when necessary, modify them to produce better fits with the pieces produced by others. I will focus on the ways in which an evolutionary framework can contribute to the refinement of social learning, cognitive-developmental, and dual-process accounts of morality, but I believe that it is equipped to refine all theories of morality. Other writers have explained how psychoanalytic models of morality can be reconceptualized profitably in evolutionary terms (e.g., Badcock, 1998).

Recognizing that the mental mechanisms that regulate social learning, moral reasoning, and moral intuitions are *evolved* mechanisms leads us to expect them to be designed in particular ways and to be activated by particular stimuli. It directs our attention to the ultimate biological function of the goals that they help people achieve. Attending to the adaptive functions of making moral judgments and behaving in moral ways induces us to recognize the inherently social nature of morality. Evolutionary theory also encourages us to attend to the order in which the mental mechanisms that give rise to moral traits evolved and to the ways in which earlier evolved and later evolved brain structures interact with one another.

Reframing social learning accounts of morality

To understand fully the role that social learning plays in moral development, we need to recognize that the mental mechanisms that mediate this process evolved because they helped early humans solve their adaptive problems. The ability to learn from others enabled members of groups to avoid the biological costs of inflexible instinctive reactions and trial-and-error learning.

Social learning theorists have conducted hundreds of studies on variables that increase and decrease people's tendency to copy the ideas and behaviors of others. This line of research has revealed that children are particularly prone to imitate the behavior of models they consider successful, competent, powerful, famous, and of high status (Bandura, 1989). By and large, social learning theorists have reported such findings in a piecemeal, descriptive manner. Evolutionary theory offers an explanation for why children (and adults) are selective in the kinds of models they imitate and the kinds of ideas they copy – namely because it was in the adaptive interest of their ancestors to model the people, behaviors, and ideas that held the greatest promise of enhancing their own welfare. Viewing the matter from an evolutionary perspective, we would expect children and adults to be sensitive to confluences and conflicts of interest with potential models. In most (but not all) circumstances, we also would expect members of groups to be more strongly disposed to copy normative behaviors than they are to copy non-normative behaviors, because it paid off better biologically in early human groups to adopt tried and true ideas and to conform to social norms than it did to defy existing social conventions. Gene-culture co-evolutionary theorists such as Richerson and Boyd (2005) have explained how the adaptive value of conformity fostered the rapid spread of moral norms.

The family contexts in which parents teach children to behave morally can be viewed as microcosms of larger social groups. Because parents and children need each other to propagate their genes, it is in their genetic interest to help one another and to uphold familial systems of cooperation. However, members of families experience social dilemmas because it is often in family members' interest to favor themselves and those with whom they share the largest complement of genes. Conflicts of interest precipitate strategic social interactions in which mothers and fathers, sons and daughters, sisters and brothers, grandparents and grandchildren attempt to induce one another to behave in ways that maximize their biological and genetic benefits (though not necessarily consciously). The ways in which members of families resolve their conflicts of interest affect the ways in which their conceptions of morality are structured and calibrated.

In attending to strategic social interactions within families, evolutionary theory helps explain why it is misguided to characterize children as passive recipients of ideas stamped into them by others, sensitizing us to the fact that social learning is often a two-way process – an insight embraced by contemporary social learning theorists (Grusec, 2006). Children are agents as well as objects, sending as well as receiving persuasive communications, exerting influence on their parents as well as being influenced by them. Even in infancy, children control the behavior of their parents by crying, cooing, and smiling.

Gene-culture co-evolutionary theories offer accounts of how social learning processes mediate cultural evolution and the ways in which cultural evolution affects and is affected by biological evolution in shaping the moral norms of different societies (Boyd, 2018). Evolutionary theory leads us to hypothesize that moral norms originate as standards designed to uphold the cooperative social orders of groups. Some moral norms, such as norms of reciprocity and fairness, are universal because

they apply to all systems of cooperation. Other norms, such as those that regulate dietary and sexual behaviors, are specific to particular groups. Implicit in this explanation for the origin of moral norms are answers to questions left largely unaddressed by traditional social learning theorists, such as why parents preach moral norms to children and why members of groups exhort one another to behave in moral ways. Gene-culture co-evolutionary theories offer explanations for intergenerational changes in moral norms (Richerson & Boyd, 2005).

Reframing cognitive-developmental accounts of moral development

Although evolutionary approaches to morality may seem to have little in common with cognitive-developmental approaches such as the one advanced by Lawrence Kohlberg, the two approaches are similar in several respects. Both approaches assume that the mental mechanisms that people use to solve moral problems are different from the mental mechanisms that people use to solve other kinds of problems, such as logical or mathematical problems. Both approaches assume that moral decision-making mechanisms are activated by moral problems such as those that involve conflicts of interest, and that these mental mechanisms are designed in ways that enable people to solve the problems. Both approaches assume that the form or structure of the judgments and behaviors produced by moral decision-making mechanisms (their outputs) reflect the ways in which the mechanisms are designed, and that the primary challenge for researchers is to map the design of these mechanisms by deciphering the operating principles, or decision-rules, implicit in their output – a process that has been called “reverse engineering.” Finally, both approaches attempt to account for how moral decision-making mechanisms change over time.

Such similarities notwithstanding, evolutionary approaches are based in significantly different assumptions from those made by cognitive-developmental theorists about how mental structures develop and the goals they are designed to achieve. Whereas cognitive-developmental theorists assume that structures of moral reasoning develop through the cognitive processes of refining and expanding one’s understanding of morality, and that people use these mental mechanisms to deduce the most moral solutions to moral problems, evolutionary theorists assume that moral decision-making mechanisms evolved through genetically induced variations in brain mechanisms selected in ancestral environments, and that the primary purpose for which they were designed was to help early humans maximize the biological benefits of social living.

Reconceptualizing the stages of moral development

Evolutionary theorists would not necessarily dispute the cognitive-developmental claim that people normally go through several stages of moral development, but they would offer a significantly different explanation for this process, accounting for developmental changes in physical and mental attributes in terms of the activation of adaptations designed to solve the biological problems animals face in different stages

of their lives. As with other mammals, the problems faced by young children pertain mainly to survival. When children reach sexual maturity, they face additional problems pertaining to reproduction. Later, as parents, they face problems pertaining not only to their own survival and reproduction, but also to the survival and reproduction of their offspring and other members of their families. Elders face additional problems, such as those that pertain to upholding the social orders of the societies in which they have invested. Evolutionary theory leads us to expect people to adopt new forms of moral reasoning in a sequence defined not only by their increasingly sophisticated cognitive abilities, but also by the types of social problems they face at different phases in their life cycle. Viewed in this way, for example, the reason that young children develop (Stage 1) beliefs upholding the duty to obey authority is because obeying authority is an adaptive strategy for relatively small, weak, and vulnerable individuals, and the reason that adolescents develop the kinds of care-oriented and in-group upholding forms of moral reasoning that define Kohlberg's third stage of moral development is because these forms of reasoning help them adapt to new social worlds containing romantic relations, coalitions, and long-term friendships.

Reconceptualizing the consistency of moral reasoning

From the perspective of evolutionary theory, we would not expect new structures of moral reasoning to replace older structures as Kohlberg asserted, and therefore we would not expect moral reasoning to be consistent across different kinds of moral dilemmas. Rather, we would expect people to retain their old structures of moral reasoning and to invoke them when they offered the most adaptive ways of solving the moral problems they faced. Adding new structures of moral reasoning is like adding new tools to moral decision-making toolkits. People select the tools that best enable them to resolve the moral dilemmas they face. It follows that from an evolutionary perspective, it is misguided to assume that people are "in" one stage of moral development – except perhaps young children who have neither the cognitive sophistication nor the incentive to make high-stage moral judgments. It makes more sense to assume that people acquire an increasingly broad range of strategies that enable them to solve an increasingly broad range of social problems. Although we might expect people to invoke sophisticated forms of moral reasoning to impress and to influence others, we would not expect them to use these forms of reasoning to guide their own behavior unless they offered effective means of achieving the adaptive goals they were pursuing.

Reconceptualizing the functions of moral judgment

In contrast to cognitive-developmental theorists who focus on the intellectual function of solving complex hypothetical moral dilemmas, evolutionary theorists focus on the adaptive functions of solving the kinds of moral problems that people experience in their everyday lives – functions such as persuading

others to behave in ways that foster their interests, justifying their moral decisions, and resolving conflicts of interest in mutually beneficial ways (Krebs & Denton, 2005). Even when people make moral judgments about the hypothetical dilemmas on Kohlberg's test, they may be motivated to achieve social goals such as impressing interviewers. Evolutionary theorists also would not expect people to derive their moral decisions from the same forms of moral reasoning that they invoke to justify them.

Different kinds of moral judgments tend to serve different adaptive functions. Although people may use third-person present tense judgments such as "Henry should apologize to Mark" or "Jane should obey the law" to explicate their conceptions of morality, they tend to use past tense judgments such as "Henry should have apologized" and "Jane should have obeyed the law" to gossip about others and pass judgment on them. In contrast, people tend to use second-person judgments such as "you should apologize" and "you should obey the law" to induce others to conform to their prescriptions and prohibitions. When people support these judgments with reasons such as "because you are going to get in big trouble" or "because this is how other people would expect you to behave," they are trying to persuade others that it is in their ultimate adaptive interest to follow their advice.

Moral judgment and moral behavior

Evolutionary theory helps explain why researchers have failed to find significant relations between the kinds of moral reasoning assessed on Kohlberg's test and samples of moral behavior. As discussed, evolutionary approaches assume that people may act without thinking much, then activate moral reasoning to justify their behaviors. In addition, evolutionary theorists expect a wide array of contextual and emotional factors to affect both moral reasoning and moral behavior. Finally, evolutionary theorists assume that people are evolved to think differently about their obligation to behave in moral ways from how they think about the moral obligations of others (including hypothetical characters). Inasmuch as behaving in moral ways is costly, we would expect people to hold others to significantly higher standards than they invoke for themselves, and inasmuch as being perceived as an immoral person jeopardizes people's welfare, we would expect people to invoke moral reasoning to justify and excuse their misdeeds.

To summarize, on the bright side of human nature, evolutionary theory leads us to expect people to invoke moral reasoning to figure out solutions to difficult moral problems, to resolve conflicts of interest in optimal ways, to persuade themselves and others to behave in moral ways, and to uphold complex systems of cooperation when it is in their ultimate adaptive interest to do so. However, on the darker side, evolutionary theory leads us to expect people to use moral reasoning to exert social influence, to win moral arguments, to persuade others to behave in altruistic ways, to justify self-serving moral judgments and behaviors, and to sully the reputations of their competitors (Haidt, 2001; Krebs, 2011).

Reframing dual-process accounts of moral decision-making

During the course of human evolution, new brain structures such as those in the neocortex developed on top of and around older brain structures such as those in the limbic system, or paleocortex. Neuroscientists have found that the brain mechanisms that mediate Type 2 rational and deliberate moral decision-making are housed in relatively recently evolved outer parts of the new brain, whereas the brain mechanisms that mediate more automatic and intuitive Type 1 moral decision-making are housed in more primitive parts of the old brain (Green, 2013). As implied earlier, evolutionary theory leads us to expect people to retain old brain mechanisms as long as they continue to help people adapt to their social environments.

As discussed, dual-process theorists have had difficulty explaining why people possess (at least) two moral decision-making systems, and what determines which system is activated. Evolutionary theory leads us to hypothesize that the first, Type 1, system evolved because it helped early humans solve the kinds of social problems they experienced in the relatively small groups they formed to adapt to their environments, and that this system is activated in modern humans by comparable moral problems in comparable social contexts. Thus we would expect Type 1 moral decision-making processes to be activated by problems created by conflicts of interest over survival and reproduction, such as those relating to food, sex, incest, and cleanliness, as well as problems created by antisocial behaviors that threaten the cooperative social orders of small groups, such as those involving physical violence, theft, cheating, and shoving someone off of a bridge (Denton & Krebs, 2017). We should be able to detect precursors of Type 1 decision-making in other primates.

Evolutionary theorists have suggested that because it is more costly in time, effort, and mental power to operate rational Type 2 brain systems than it is to operate emotional and intuitive Type 1 brain systems, the latter should serve as the default system. In most of the situations in which people find themselves in their everyday lives, it is more adaptive to go with one's moral intuitions than to expend the mental energy to think issues through. As expressed by Green (2013):

Nature doesn't leave it to our powers of reasoning to figure out that ingesting fat and protein is conducive to our survival. Rather, it makes us hungry and gives us an intuitive sense that things like meat and fruit will satisfy our hunger. [In a similar vein,] nature doesn't leave it to us to figure out that saving a drowning child is a good thing to do. Instead, it endows us with a powerful "moral sense" that compels us to engage in this sort of behavior (under the right circumstances). In short, when Nature needs to get a behavioral job done, it does it with intuition and emotion whenever it can.

(p. 60)

In addition, we would expect primitive forms of moral decision-making to predominate when people anticipate that reason will produce solutions that go against their social and biological interests. The threshold for emotional and intuitive judgments should become lower when people are in highly emotional states and when their rational cognitive abilities are being taxed by other tasks.

Because humans are the only species in which brain structures capable of performing sophisticated Type 2 forms of moral reasoning (such as those studied by cognitive-developmental psychologists) have evolved, evolutionary theory leads us to hypothesize that humans must have experienced different kinds of moral problems from those experienced by other species – moral problems that could not be solved effectively by primitive decision-making processes (Denton & Krebs, 2017). Based on the positive correlation between brain size and group size in social animals, there is a basis for hypothesizing that these problems stemmed, at least in part, from complex systems of cooperation and social relations within and between members of large groups (Dunbar, 2007). This hypothesis leads us to expect Type 2 moral decision-making to be activated by problems related to indirect reciprocity, cultural innovations, international relations, and global issues such as those involving climate change, the spread of diseases, and nuclear armament. In addition, we would expect rational moral decision-making processes to be activated by subtle, nuanced, and ambiguous moral problems, such as those contained in philosophical moral dilemmas, especially when the costs of deliberation are low, when the benefits of making rational decisions are high, and when people have the time, incentive, and motivation to think things through (Denton & Krebs, 2017).

The meaning of morality

I opened this chapter by asserting that there is little agreement among philosophers, scientists, and laypeople about the meaning of morality. The evolutionary approach I have outlined implies that to define morality, we must attend to what it is for – the adaptive functions it evolved to serve. All, or at least most, manifestations of morality share the same feature – they uphold biologically beneficial systems of cooperation. What the wide array of moral traits and conceptions of morality investigated and espoused by scholars who are guided by different approaches have in common – whether the approaches focus on moral emotions, moral intuitions, moral ideas, moral virtues, moral reasoning, or moral behaviors – is that the mental mechanisms that produce and regulate them were selected because they helped early humans solve the problems of selfishness that inhibited their ability to adapt to their environments by collaborating with others. Philosophers in search of ultimate moral principles would do well to attend to the implications of this point. An evolutionary approach implies that the most ideal moral principles are those that contain the greatest potential to maximize the biological benefits of cooperation.

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6

IN SEARCH OF BASELINES

Why psychology needs cognitive archaeology

Darcia Narvaez

The societies where psychology has its deepest roots are those that have promoted the devastation of biocultural diversity around the world and led us to the brink of planetary disaster (Amel, Manning, Scott, & Koger, 2017; Steffens et al., 2018; Trout, Stockman, Rubinstein, & Maiorana, 2019; Turner, 1994). Yet, the institutions of contemporary psychology do not systematically critique these societies or their institutions; rather, they instead help citizens to “adjust” to a life-destroying culture (Kidner, 2001). The inability to critique one’s own fishbowl is not a surprise, but psychology may play a significant role in perpetuating the systems that destroy life around the world, based on a web of myths in which they swim. Now that we have reached a critical point on the planet, it is imperative to re-think the assumptions, emphases, and orientation of psychology. Cognitive archaeology is poised to offer critical corrections and insights.

Ghost theories and fishbowl views

The strange pathway of psychology is haunted by the ghost theories that are rampant in Western culture, shadowing science generally (Small, 2008). Multiple myths undergird psychology’s worldview, and although there is a lot of backstory for each, there is room only to mention them briefly. Here is a short list of misguided theories, some of which are ghostly and others that seem to be fully embraced.

Foreshortened view of humanity

Although rejected by science the literalist biblical interpretation of a brief existence of the universe and humanity – around 6,000 years – continues to be the time period of concern to most scholars investigating human psychology. In fact,

associating itself with civilization and writing, Western scholarship has a tendency to take seriously only the earth-detached cultures of the last millennium (sometimes dipping into ancient Greek philosophy for virtue studies).

Negative view of human nature

As part of the emphasis on civilization, most scholars in most fields narrow their scope to the characteristics of the members of dominant Western empires, presumably believing that they are the most advanced on the progress pathway. Yet even with a secular focus, the otherworldly religious belief in the “original sin-fulness” of humanity is still deeply embedded in Western assumptions. Too often we hear that humans *need* civilization (i.e., hierarchical order within agricultural settlement) to behave properly and control selfishness and aggression (Hobbes, 1651/2010; Pinker, 2011) – i.e., civilization made humanity and not the other way around (Small, 2008). Such cultural biases often lead to a misinterpretation of Palaeolithic evidence that then becomes popular and “goes viral,” reverberating as a meme about humanity’s negative, deplorable past. A choice illustration is the work of Dart (1949), who interpreted head trauma among cave remains of Australopithecine skeletons as conspecific murder with three-pronged clubs (generating the cartoon stereotype of the club-wielding caveman). The more parsimonious interpretation is that the humans were prey whose skulls bore marks of leopard teeth (for discussion, see Fry, 2006). Such misinterpretations are easily passed on without critical examination if they support the view that humans are naturally flawed and must be controlled with civilization (as depicted in the film *2001: A Space Odyssey*). In the Western mind, civilization represents progress.

Bias toward literacy

Psychology has its roots in Western philosophy, which is deeply grounded in the writings of (usually Western) civilization, a few millennia old. As Small (2008) states: “[T]he insistence on the written is a patronizing denigration of the oral, a persisting and blind denial of the fundamental role of memory as an archival and historical medium in all Postlithic societies” (pp. 58–59). The denigration of oral culture may be due in part to the deterioration of memory capacities among modern humans who rely extensively on external memory aids and so do not know what they are missing. In comparison to those from literate societies today, members of nonliterate societies show astounding endogenous memory and little ego-self awareness (Ong, 2002; Wolff, 2001; van der Post, 1961). In fact, reading and writing appear to alter the nature of cognition and ways of thinking. In writing and reading, humans detach from embeddedness in the present moment and focus attention in a narrow manner rather than holistically. They begin to intellectualize more, a capacity that religious traditions and First Nation societies distrust (Bourgeault, 2003; Deloria, 2006).

Negative view of prehistory

Although the predominant view of prehistory among those subscribing to linear history and human progress is negative, when the negatives of *modern* over prehistoric life are examined they focus typically on the physiological or social differences that occurred with the development of settled societies and mono-agricultural fields. For example, many have noted that as civilization evolved it brought about impairment after impairment in human health (e.g., shorter stature, epidemic disease, dental decay, diabetes) (Cohen & Armelagos, 2013; Larsen, 2006; Wells, 2010); increased aggression, territoriality, and warfare (Johnson & Earle, 1987); and deteriorating status and wellbeing of women (Whyte, 1978). But then, when for some malady caused by civilization a remedy is invented, it is hailed as a sign that civilization is better than anything in the past. Such remedies only treat the symptoms and not the cause – civilization itself.

Misunderstanding of human potential

Psychological differences between industrialized and small-band hunter-gatherer (SBHG) life, representative of 99% of human genus existence, often are minimized or ignored. For example, leaders in what I call the Hobbesian version of evolutionary psychology contend that “humans are the same everywhere” (Tooby & Cosmides, 1990). But humans are not the same everywhere. There are considerable psychological differences between the industrialized and SBHG that characterized most of human species’ existence. The contrast between civilized and indigenous (First Nation) peoples the world over could not be starker. First Nation peoples perceive themselves as part of the fabric of life, always situated relationally, dynamically in relation to the natural world; they have small egos but large selves (Descola, 2013; Ingold, 2005; Redfield, 1956). SBHG and similar societies show a great deal of extra-human awareness and interconnection, showing expanded capacities to take the perspectives of local animals and other-than-animal life (plants, rivers, mountains). This multiperspectivalism is fostered in the communities by local story and practices like trances through dancing and singing. Entrancement allows for receptive attunement to life energies in the vicinity, often as a means to promote balance and flourishing within the biocommunity but also to remind the humans that they are part of the circle of life, not separate or superior (Descola, 2013; Katz, Bieseke, & St. Denis, 1997; Kohn, 2013; Mann, 2016; Shepard, 1998).

Bias toward individualism

Psychological theorizing and research have largely focused on the type of human psychology one finds within civilized societies, particularly industrialized societies, making it logical to favor Western culture’s individualistic orientation. Children are forced into individualism with poor neurobiological development in

early life, leading to social disconnection (Narvaez, 2014). As David W. Kidner points out:

Ideological convergence between psychology and industrialist society has two major effects. Firstly; it makes psychology's assumptions about a particular style of individualism seem natural and unremarkable, since we ourselves are constantly making the same assumptions; and secondly, it obliterates psychology's potential capacity to comment on and critique the particular forms of personhood, behavior and experience that are accepted as "normal" within the modern world. And this is the major source of psychology's inability to contribute to any radical environmentalist critique of modernity; for it is precisely these "normal" forms of personhood, behavior, and experience that are implicated in the exploitation and dismemberment of the natural order.

(2001, p. 50)

Civilization, especially the Western version, has increasingly set itself in opposition to the natural world, from the first enslavement of plants and animals to the intentional extermination of "pests" (Merchant, 2003; Turner, 1994).

Bias toward abstraction

Language matters. Psychology has been dominated by the nature of modern languages, which emphasize abstraction and viewing the world as full of objects ("tree") instead of as full of movement and living beings, as is common in, for example, Native American languages ("tree being"). Along with the type of neurobiological development described later, such languages make it easy to assume that order is imposed by language and that humanity thus orders nature, standing apart and without constraint from nature (Kidner, 2001). Kidner opines: "Academia has long been a faithful advocate of this project, following the guidelines of a long philosophical tradition stemming from Plato, through Kant, to postmodernism, that sees order as necessarily imposed by human understanding" (p. 20). Worse, psychology has imposed its own order on human nature, inventing human beings as individuals detached from the rest of the living world: "This substitute person created by the psychological experiment, the modern counterpart of the dispassionate Cartesian 'knower,' is a thinking, deciding creature which . . . is relatively unemotional and unsocial and is notably detached from the world it relates to as a passive, formless background to its decisions" (p. 49). Detachment and disconnection are what moderns drag through their lives.

The values psychologists hold implicitly or explicitly emerge from these same biases and guide their fact-finding. Western psychology has followed the narrowed scope of scholarship predominant among all fields about what data to take seriously and what is normal, as if only recent and familiar ways of learning and being are acceptable forms. Western and Westernized scholarship has long been criticized

as narrow and hegemonic for the contemporary worldscape. The vast, worldwide insights from visions and dreams transmitted orally among pre-civilized peoples through narratives over generations, for example, are dismissed even when they are confirmed by contemporary scientifically derived conclusions (Deloria, 2002). Thus, consistent error is repeated and perpetuated through psychology when it uses its own narrow frameworks of perception and interpretation.

One of the reasons for the twisted path of psychology is that the field lacks reliable baselines and parameters for species-typical functioning and potential. Psychology has adopted the narrow scope of Western philosophy, which sets baselines within the period of civilization with a focus on extant writings (i.e., from Europe). By ignoring worldwide insights through human species history, it misleads. Cognitive archaeology can help shed light on what appropriate baselines might be.

Establishing baselines

A notion that emerged from oceanography is that of “shifting baselines” (Pauly, 1995). It was found that the assumed baseline for what was deemed normal in ocean health was what the scientist experienced in his or her childhood. As a result, scientists were blinded to the changes that were occurring generation by generation (e.g., the decrease in number and variety of species; ocean ecology is set to collapse by 2048; Worm, 2006). I think something similar occurs across virtually all areas of Western scholarship.

Currently, psychology ricochets among arbitrary baselines and limited parameters of behavior, often unconsciously selecting one or another as “normal” for the human species (e.g., war, rape, male dominance; Lewis, Al-Shawaf, Conroy-Beam, Asao, & Buss, 2017). Often the only data relied upon are data the field of psychology itself has generated, despite its relative infancy. Embracing a positivistic orientation, psychological scholarship does not advance unless a convincing experiment has been done (e.g., we cannot know whether a mother’s breast milk is better for a baby’s intelligence than the scientist’s formula, even though breast milk has thousands [versus dozens] of tailored [versus nonhuman], mostly alive [versus non-living] ingredients and is a multi-million-year adaptation [versus multi-million-dollar endeavor]; Braden & Narvaez, in press).

One key shift causing changes in psychological capacities and orientation is the deterioration of care and experience that young children receive, a deterioration that has continued over the last millennia, centuries, worsening in recent decades (Narvaez, 2019b). Elsewhere, I contend that baselines for children and their developmental outcomes continue to shift downward at multiple interacting levels within Western-based societies and social sciences: (a) what is considered normal child raising environments, (b) capacities for self-regulation and wellbeing expected to develop in children, as well as levels of wellbeing and wisdom expected in adults, (c) the cultural supports adults design for human development, and (d) capacities for connection and orientation to nature (Narvaez, 2014, 2018). Baselines for normality have shifted across the board. The shift starts with the evolved nest, the

developmental system that evolved to match up with the maturational schedule of the young.

The evolved nest

Every animal has its nest, a set of characteristics routinely provided to the young to optimize normal development. As social mammals, humans have a set of basic needs that are particularly important to meet in early life, because of great plasticity and epigenetic effects at that time (Gómez-Robles, Hopkins, Schapiro, & Sherwood, 2015); the individual's brain and body are being co-constructed by a built-in maturational schedule and expected biosocial experience (Narvaez, 2016a; Narvaez, Panksepp, Schore, & Gleason, 2013). For humans the evolved nest includes responsive care to keep the young child optimally aroused; several years of on-request breastfeeding; constant then frequent affectionate physical touch; multiple responsive adult caregivers; positive support for mother and child; positive social climate; self-directed free and social play in the natural world; as well as soothing perinatal experience (Konner, 2005; Narvaez, 2018). My lab finds that the evolved nest is related to wellbeing and morality in children and adults (e.g., Narvaez, 2016b; Narvaez, Gleason et al., 2013; Narvaez, Wang, & Cheng, 2016; Narvaez, Wang et al., 2013; Narvaez, Woodbury et al., 2019). The evolved nest provides the buffer for genetic variation, supporting healthy outcomes and the kind of cooperative, calm, and generous personalities that adults worldwide display in cultures that provide the evolved nest, small-band hunter-gatherers (Ingold, 2005; Narvaez, 2013). The evolved nest then can be described as a “cultural commons” for the development of a cooperative human nature (Narvaez, 2014).

With data on the lifeways of still extant uncivilized groups, scholars note their sustainable lifeways and their aims for flourishing. For example, the San Bushmen of southern Africa have existed for at least 150,000 years (Suzman, 2017). The awareness that some human groups have existed for such a length of time opens the eyes to the possibility of sustainable societies, contrary to the view that humans are by nature prone to destroy their environments because they are part of a dog-eat-dog world. When these societies are examined for their practices, they show the ingredients for sustainable living, many of which are matched by nomadic foragers the world over: fierce egalitarianism, high autonomy paired with high communalism (Hewlett & Lamb, 2005; Ingold, 2005; Narvaez, 2013). Providing the nest supports these outcomes (Narvaez, 2013, 2014). A degraded nest undermines the course of human development, in ways such as the following.

Shifts in intelligence and sociality

The endogenous capacities of right-hemisphere function develop unperturbed within the cultural commons of the evolved nest – capacities for “moving with” others, empathy, self-regulation, higher consciousness. The nest offers the neurobiological, social, and cultural cultivation of receptive intelligence, the capacities for

tuning into and responding to the dynamism of living systems and communications from other-than-human entities. Nested childhoods encourage full development of human capacities (Turnbull, 1984). Perception and worldview are shaped in early life by movement and play in the social and other-than-human landscape. The child discovers the way the world is made (Cobb, 1978). The indigenous worldview orients to living, dynamic relationships and can be said to be “right hemisphere driven” (Narvaez, 2014). The roots of multiperspectivalism, shape-shifting, and multiplicity of thought – expanded cognition among living beings – are established in childhood and nurtured life-long. Traditional intelligence is less about a mental capacity situated within an individual than a joint property shared with the physical world (Ingold, 2011). The individual human must be attuned to the signals within the physical world in order to interact intelligently with it. Perception is multiperspectival. Thought represents forces outside the self. For example, the Inuit artist follows intuitions about how to carve the ivory, wondering, asking “who are you,” as they reach for the inner form. The artist releases the inner form of the stone, ivory, or wood; they do not “create” or “make” the resulting figure (Carpenter, 1973). Industrialized minds tend to dismiss or even obliterate such forms of intelligence to maintain the monopoly of disembodied (“objective”) rationality taught in schools and assumed necessary for living a proper life. Of course, the enforcers themselves do not know what they are missing, that there are alternatives, but fear the wild, unnamed, uncontrolled “otherness” of a different way of being.

Fragmented cultural narratives

The missing capacities among the civilized may have much to do with the worldview that has colonized the world. According to Robert Redfield (1956), there are essentially two worldviews. In one, the more ancient and primary, the cosmos is considered moral, sacred, and unified. It turns out that this is an orientation guided by the right hemisphere (Taylor, 2008). This way of being and perceiving is a mostly slow, intuitive process that requires development and trust of right-hemisphere capacities, while quieting the explicit, verbal mind. The other worldview, species-rare but dominant today in civilized nations, considers the cosmos to be amoral, fragmented, and disenchanting, impressions that follow left-hemisphere-directed perception – the detached, categorizing, serial thinking way of being (McGilchrist, 2009). The takeover of the left hemisphere in, especially, Western civilization has led to consistently limited understandings about the human species and its potential.

Adult underdevelopment

Modern humans are missing many capacities that are shaped and formed in early life when most brain development occurs. “Many traditional connections to the natural world are of a felt, visceral nature, and these have often been displaced by more immediately striking visual/rational modes of relating” (Kidner, 2001, p. 28). With undercare of young children, the right hemisphere is underdeveloped, and one

must rely instead on left-hemisphere preferences: vision, categorization and conscious deliberation – left-hemisphere favorites (McGilchrist, 2009).

Today's central disorder: nature disconnection

One of the most striking differences between traditional societies and modern civilizations is a breakdown in nature connection. The shift away from nature connection seems to have begun with the shift to agriculture and “enslavement” of particular fast-growing weeds (chosen from a minority of plants that are willing to grow in disturbed soil) for a controlled food supply, but also through the enslavement of animals through domestication, dumbing them down to shadows of their ancestors (Martin, 1992; Scott, 2017). The move to cities necessitated the takeover of other people's lands for supplies but also decreased familiarity with and connection to other-than-human wildlife, increasing a sense of fear of wildness (Turner, 1994). Humans began to think of themselves as separate from nature and then superior to it (Merchant, 2003). In the last millennia, a detached view of living with the natural world was encouraged among intellectuals and colonizers. Arguably, although capitalism of the last few hundred years has brought about planetary-level devastation (Bollier, 2014), the roots of the crises underlying modern life were formed in ancient civilizations such as the Greek and Hebrew. For example, the Greek Parmenides emphasized a static view of the world and ended up triumphing over his rival Heraclitus' dynamic view (“you never step into the same river twice”). Parmenides' view can be described as “left hemisphere driven,” documented to be attracted to static, inert views of the world, shaping the type of science and technology to come. In more recent centuries this detachment from nature accelerated with the feverish rise of industrialization, unfettered capitalism, and colonialism. The mechanistic view of the world was encouraged by the dominance of the left-hemisphere orientation in Western human life (McGilchrist, 2009). Perceiving the rest of the world as a set of objects makes domination and control seem logical. Controlling nature still is viewed as “progress.”

Fundamental to the Western world of the last centuries has been the separation of society (Western European) from nature (the natural world, women, other cultures) (Moore, 2015). As Moore (2016) notes, Western philosophers guided Western expansion with the idea that society and nature were separate and that nature is inert, inferior, and full of objectified resources to be used at human will. And the assumption was that only the conquering Europeans were part of society. All other humans were part of “nature,” to be exploited for the use of “society.” As civilized humans distanced themselves more and more from nature's ecological cycles and fought against them, they forgot how to live respectfully with nature so that it flourishes along with human beings (Merchant, 2003; Song, 2016). Thus, one of the major flaws of civilization is its anthropocentrism, its narcissism, leading to a degradation of status of other-than-human entities, from plants and animals to mountains and streams, altering their perceived nature from sentient agents to objects. For over four centuries, dominant societies considered nature as inert or dead (Plumwood, 2002).

This attitude is also known as human supremacy (Jensen, 2016), human exceptionalism (Smith, 2014), human chauvinism (Routley & Routley, 1979), human exemptionalism (Dunlap & Catton, 1979), speciesism (Singer, 1975), and resourcism (Orton, 2011). These are accompanied by biocidal practices, which have characterized Western European explorer and settler practices (Scott, 2017; Turner, 1994).

Lacking among civilized cultures is a sense of sentience in All, that every action has an influence on the Whole, much like walking around on a trampoline or spider's web. The whole thing vibrates. Without the development of one's right hemisphere and its sensibilities of connection (in early life with the evolved nest; in later life with trance practices), the sense of connection is rare or missing. Instead of developing this holistic sensibility, the child within a degraded nest tends to develop a one-person psychology, disconnected from the All. A one-person psychology (individualism), engraved neurobiologically in early life, haunts the life of the industrialized individual (Narvaez, 2014).

Perhaps as a result of decreasing endogenous capacities from a degraded evolved nest, industrialized societies have grown mechanized external memory systems (Donald, 1991), "extending the mind" with tools and devices like computers (Clark, 2008), a more left-brain expansion than in our prehistory, with a focus on static information exchange. This latter move forms a part of the story of "human progress" through civilization, detaching further and further from receptive intelligence with living earth entities and a sense of partnership with the natural world. The detached, imperceptive orientation indisputably has led to the destruction of the ecologies of planet earth (Merchant, 2003; Moore, 2016). What most scholars seem to miss is that civilized humans have been shaping themselves away from nature connection and ecological wisdom for some time, as they have moved further and further from provision of the evolved nest (Christen, Narvaez, & Gutzwiller, 2017).

Provisioning the evolved nest used to come naturally to human communities, but has been undermined in civilized nations for a host of reasons, including the view that babies are born with original sin and must be treated harshly to shape them morally (Narvaez, 2019b). Instead of understanding babies and young children as "humans in the making" whose brains and bodies need tender care to grow into intelligent and sociable creatures, today's cultural beliefs in regions within the US (as in Nazi Germany) espouse the need for children, who are assumed naturally rebellious, to have their spirits broken – for religious (Dobson, 1992) or political (Haarer, 1934; Miller, 1983/1990) control. Unfortunately, even the scientists got in the act to advocate ignoring babies (Watson, 1928), advocating harshness (Suttie, 1935), a cultural meme still embedded in US parenting advice. In US culture today, many adults expect parents to control their children in ways that minimize their disruption of adult activities. Unfortunately, this has led to intrusive parenting (tiger moms, lawnmower parenting, baby-busting) that actually undermines the autonomy and self-development of the child. Moreover, development in ancestral settings requires dynamic learning through social interaction with natural elements. In most societies during most of human existence, the evolved nest included relational partnership with other than humans. As noted earlier, changes in child raising practices

may have been integral for the cause and consequence of degraded human capacities and the devastation of relations with nature (Narvaez, 2014).

The reluctance to integrate ethology and anthropology into psychological theory may be due to a reluctance to admit that humans are animals who share characteristics with other mammals (e.g., 20–40 million years of social mammalian history). There is also the sense that the civilized have nothing to learn from non-civilized people. Kidner notes:

The danger here is that “understanding” becomes a rationalization of current practices, and a substitute for and an alternative to *change*, since this understanding *presumes* the split between self and world. It conceals rather than illuminates the way environmental problems are mute expressions of an incompatibility between the social phantasy systems that we inhabit and those characteristics of the natural world that we are not only unaware of, but are unaware that we are unaware of.

(ibid., p. 13)

The human nature psychologists reference becomes “the cultural artifact they theorize about rather than the natural order whose existence they are oblivious to” (Kidner, 2001, p. 9). The biases that psychologists display are woven through their work: the questions studied, data attended to, their interpretation and application. But overall, they stay within their cultural bounds and implicitly enforce their framework as natural or normal.

The promise of cognitive archaeology

Understanding where we have been can help us figure out how to move forward. Cognitive archaeology can provide species-typical grounding for assessing human development and wellbeing and the parameters for human potential. These efforts are vital in the age of the Anthropocene – or more appropriately perhaps, the Capitalocene (Moore, 2016), because it is not all humans that have brought us to the brink of planetary disaster, as the term “Anthropocene” implies, but only a subset of humans guided by eco-destructive notions, some of which were briefly described earlier. Cognitive archaeology can help shed light on alternative ways of being.

Can cognitive archaeology make us less anthropocentric? Surely, we can acknowledge the cooperative nature of Nature, the intricate mutualisms that pervade every intact ecological system, increasingly lauded by scientists and writers (Bronstein, 2015; Margulis, 1998; Paracer & Ahmadjian, 2000). Interlocking sharing goes on at every level. For example, older trees in forests act as parents to younger trees, even those of different species, sending nourishment through their roots (Wohlleben, 2016). Humans themselves carry mostly nonhuman genes (90–99%) from the trillions of microorganisms that keep them alive (Dunn, 2011). Cognitive archaeology has been able to discern the spread of adult milk-drinking across Europe where hunter-gatherers were wiped out by cattle raising groups (Curry, 2013). The next

step is to assess the effects of this change on human cognition. The nature of one's microbiome, reliant on what ecologies we are exposed to, influences mental capacities and even personalities (Bercik et al., 2011; Bravo et al., 2011; Clarke et al., 2012; Denou et al., 2011). Cognitive archaeology in its broadest sense promises to open wide our perspective on humanity's movements and perhaps also its predicaments (overpopulation, ecological devastation, anthropocentrism).

Cognitive archaeology counters the foreshortened view of human history and the emphasis on civilization's unmitigated progress. Can it go further? Instead of taking for baselines anything from civilized societies as representative of typical human species behavior, cognitive archaeology allows us to see more broadly. Cognitive archaeology can lengthen our view of humanity by extending into deep history. We can find out a lot about humanity from sources other than writing, such as the early traces of language and DNA sharing. Biological archaeology has brought about awareness of connection to other forms of life – shared DNA with mushrooms and bananas extends our understanding of humanity's integration with the rest of nature. Cognitive archaeology can help reset baselines in psychology by expanding our imaginations. Social mammals emerged around 20–40 million years ago with humans showing up around 6 million years ago. That is a lot of history relevant to human psychology from which psychology could profit. Perhaps psychology needs the hand holding of cognitive archaeologists to expand what counts as data and scholarship into human nature. Cognitive archaeologists can help psychologists learn to honor and integrate all of human experience. Understanding human nature before writing was invented may provide new avenues for moving away from the philosophies and psychologies of the “European raiding culture” (B. Mann, 2019) that has led to planetary destruction. After all, both psychology and cognitive archaeology are aimed at understanding the singularity of humanity.

Cognitive archaeology allows us to take seriously all the various alternative ways of being members of the earth community that anthropologists and others have identified among non-industrialized societies around the world. Instead of categorizing them as barbarian primitives, we can see that the barbarians are us. We are the ones destroying the planet from a lack of connection and entwinement and an inability to take the multiple perspectives and ways of being in nature (Washington, 2019). We civilized persons have lost the connection to the otherness, a multiplicity of nature, that the natural world provides and that is needed for proper human nature development and sustainable coexistence (Shepard, 1982).

There are several things that cognitive archaeology may have more difficulty providing evidence for, such as the importance of relationships. Nature operates on a gift economy – each creature taking a little (food) and giving back food for others (waste, extra young) in endless interdependent cycles. Mutual sharing often occurs in exclusive partnerships, as with each orchid and its insect partner (Haraway, 2016). Maternal gifting is central to the human species (Vaughan, 2015). Instead of genes determining outcomes, experience does (Narvaez, 2019a). What records of these things are there? This is where perhaps ethology

offers more guidance. As humans are social mammals, we can study the species-typical nest and observe how those characteristics are related to better and worse outcomes. Nevertheless, cognitive archaeology has promise to expose human cooperation: Extensive caring for the disabled has been found in ancient remains (Spikins, 2015).

A second related aspect of uncivilized life difficult to discern is dissolved artifacts. Human evolution in its broadest sense is about coordinating human niches with those of the rest of nature – a symbiotic mutualism (Fuentes, 2014). Is it possible to note how a society followed or not nature's economy/laws? Uncivilized societies, which tend to be less anthropocentric as a matter of survival, often do not leave lasting marks for archaeologists to find later (though see Balter, 2012). However, representatives of our evolutionary ancestors are still here, allowing us to learn more about the centrality of human cooperation. Unlike most great apes, the human species is known for food sharing (e.g., Isaac, 1978) even with non-kin groups at a great distance (Hill et al., 2011).

Conclusion

The “agrologistic” shallow thinking about human behavior that guides dominant cultures is accompanied by fishbowl beliefs that keep us on the pathway to self-destruction (Morton, 2018). Cognitive archaeology can help break the fishbowl and lead us to swimming in earth's waterways instead. The bias toward individualism and abstraction can be questioned. Cognitive archaeology can lengthen the view of humanity and propel a more positive view of human nature and human potential with a brighter, clearer lens of prehistory. Cognitive archaeology can help us understand that nature *predates* human beings, by billions of years, which may relieve our tendency toward hubris and the belief that humans impose order on nature. Most importantly, in this era of planetary destruction, the orientation against nature can be understood as an aberration in the course of human and planetary existence.

A return to the indigenous worldview and sustainable lifestyles is critically needed if the human species is to survive as a social mammal (Narvaez, Arrows, Collier, Halton, & Enderle, 2019). Expanding our imaginations, or re-rooting them in the otherness of nature, makes us realize our oneness with the natural world. We can once again understand the world to be made up of

eternal and recurring patterns, to which fertility and fatality are crucial, hence death is positive and recyclic. Time is synchronous: the past and future are enfolded in the present. Metamorphosis is central but oriented to stability rather than change. Nothing is fortuitous. The principles of totality, predictability and regularity are important. Nature and culture are in sacred symbiosis; alien cultural systems are merely different expressions of that same embeddedness. Man is at home in the world.

(Shepard, 1982, p. 56)

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7

PLAY

A neglected factor in ritual, religion, and human evolution

Gordon M. Burghardt

A book on psychology and cognitive archaeology in ancient times is bound to be awash in speculative propositions, albeit grounded in careful scholarship and empirical findings. As such, the many tentative, and not so tentative, conclusions and claims found here draw from diverse fields and are not always congruent, let alone in harmony. This is expected when breaking new ground. Indeed, my impression from some of the papers in this volume is that they are the products of play, “serious” playing with ideas in attempting to make sense of whom we are and how we got that way as a species. I am sure many of the contributors would largely agree, but I am going to go much further and make the case that the key to understanding the evolution of modern humans and their social and cultural lives is studying, and understanding, play in all its rich messiness. This contribution can be viewed as a strong, albeit controversial, counterpoint to other chapters. In fact, I think it may aid in developing a more integrative and, at some level, complementary perspective. Many chapters in this book focus on the origins and functions of specific traits, found almost exclusively, or most importantly, in humans and thus highlighted as critical and crucial. These include language (Donald), innovation/generativity (Corballis), morality (Krebs), ritual (Rossano), religion and science (Nielsen), cooperation (Sterelny), deception and manipulation (Hayden), symbolic rituals and intersexual competition (Power), and so forth. For example, Rossano claims “that ritual made us human.” In contrast, I argue that to a significant extent, ritual and all these other important human attributes are influenced by, if not derived from, play. As one who is clearly an outsider to the weighty issues contemplated in this volume, one who began his career studying snake behavior (and still does), I will begin and partially telegraph my position through a lightly edited blog entry (Burghardt, 2014, February 17) quickly written and posted upon hearing about the death of a friend.

Faith, play, and the death of Jamie Coots

Yesterday (Feb. 16, 2014) Jamie Coots, pastor of Full Gospel Tabernacle of Jesus Name, died of snakebite in Middlesboro, KY. I visited his church several times, met his family, and was prepared to testify on his behalf at his trial in Knoxville for illegally transporting snakes through Tennessee until the case was plea-bargained at the last minute (an event depicted in the National Geographic series *Snake Salvation*). His death is a sad event, and I grieve for his family, friends, and church members. Yet this tragedy led to some reflections that may be more germane than one might suspect. They revolve around the phenomenon of play and the enduring “faith versus reason” debate that has animated Christian theology for many centuries, and is alive and thriving yet today. The death of Jamie Coots, while certainly not uncommon among adherents of the serpent handling tradition, has brought some truths home to me in a personal way. First a little backstory.

As a scientist focusing on snake behavior, I have long had an interest in the role of snakes in human culture and how we react to them. When I moved to the University of Tennessee 45 years ago, I had heard about the serpent handling Pentecostal tradition but knew little about it. Ralph Hood, at the University of Tennessee in Chattanooga, has subsequently studied the tradition extensively with colleagues and among other publications has a fine book, *Them That Believe* (Hood & Williamson, 2008), that corrects many of the misconceptions about this practice and its adherents, especially by those who disparage the handlers as fanatics, ignorant, and theologically grossly misinformed.

Although my love for studying reptile behavior is undiminished, I also study play, and among other topics developed criteria for identifying play in animal species and contexts where it might not seem to exist in *The Genesis of Animal Play: Testing the Limits* (Burghardt, 2005). Although my initial interest in snake handling focused on the snakes and their behavior, something students of serpent handling typically ignored, I had an epiphany experience at Jamie’s church a few years ago when it became clear to me that snake handling was, in fact, play. These folks are engaged in a form of risky play, certainly known to adolescent males, but much more widespread than one might think.

While I have written a little about this and given talks making my case, currently I am a Fellow at the Center of Theological Inquiry in Princeton where my project is to develop the thesis that play is the source of rituals in religion and other contexts. While this is not an original idea, it has not been empirically tested. My project is to use Pentecostal snake handling as a test case, since it is a relatively young (about 100 years old) and well documented ritual. Furthermore, Ralph Hood and his colleagues have amassed hundreds of hours of video from many churches in several states in the Southeast over decades, including two and more generations of handlers, many of which are on my computer as I write.

While the handlers may not view their behavior as playful, but serious worship of God, these views are not incompatible. In fact, a handler in Tennessee was quoted

in a radio talk show as saying that his relatives, not from the tradition, say he is “like a kid in a candy store” when handling snakes, a quotation he confirmed to me. My analysis of videos shows that for these highly traditional and conservative folks, the services allow them to dance, sing, speak in tongues, and play music in a most uninhibited way (often discouraged in secular contexts), as well as play with snakes and fire.

My time at the Center in Princeton has exposed me to colleagues who are examining long-standing theological issues concerning virtue, morality, happiness, mysticism, and religious experience, and relating them to current findings in human evolution, neuroscience, psychology, and other fields. Many work in schools or departments of theology and conduct their research in relationship to a particular Christian tradition, working on interdisciplinary projects that require an interaction between the findings of science and the commitments of these traditions. While many theologians have no problem with biological evolution, an old earth, modern medical treatments, and other views and practices that were once considered incompatible with Christianity (and sometimes still are), they are also dealing, to varying degrees, with the faith versus reason dialectic that goes back to St. Augustine, Aquinas, Occam, and others. They entertain topics – like the incarnation, trinity, and resurrection of Jesus – that they view as outside the explanatory reach of science, to be accepted on faith, even when science is rather unsupportive.

The death of Jaime Coots and churches such as the Full Gospel Tabernacle raise, for me at least, a different level of conversation. I am not interested in the fact that the serpent handling tradition derives from a literal interpretation of the end of the Gospel of Mark that virtually all Christians reject. Rather, it highlights recognizing that faith, indeed life itself, is serious play, the ultimate game.

What often perplexed me, as well as others, was that snake handlers, if bitten, refused medical treatment, which also occurred with Jamie. Why would they do this? Hood and Williamson interviewed many handlers who received serious bites, and while the explanations varied as to why they were bitten, the bites themselves engendered feelings of suffering, surrender, and ultimate victory regardless of whether they survived or died. It was up to God, at this point, to determine their fate, not mortal men with their medicines. Handlers accept medical treatment for other illnesses, so this is far from total reliance on faith healing. What I think is going on reinforces venomous snake handling as play, a risky game. For if one loses a game, or a call goes against you, you do not protest if the infraction or loss was fairly rendered, or claim to be a victim of cheating. Only poor sports, sore losers, and whiners try to reverse the call or scoreboard. Putting one's faith in God is the way faith in religious matters plays out! Although most bites by venomous snakes are not fatal, many handlers are missing digits (as was Jamie) and have horrible scars, often on their arms and faces, from nonfatal bites. Could this be a slot machine gamble in reverse?

Returning to faith versus reason, how many of those who espouse the primacy of faith over reason would do so to the extent of the handlers? To accept or not the trinity or incarnation is, today in the US, not a matter of life or death. One is not

really testing anything or putting faith ahead of reason except for a posited reward after death. The snake handlers, however, do so by really acting on their beliefs, and with joy and acceptance. Are they, then, truer followers of Jesus than the many who find numerous excuses to ignore the clear teachings of Jesus on compassion for the poor and prisoners, turning the other cheek, the evils of wealth, and other inconvenient claims? The 84-year-old nun Megan Rice is willingly facing spending the rest of her life in prison for breaking into and harmlessly defacing, in playful fashion, the nuclear bomb production facility at Oak Ridge, Tennessee, near my home university and where I live. Acting on her faith as to what Christianity demands seem irrational, for she and her convicted compatriots are considered dangers to the state, traitors to be convicted, rather than exposing the poisonous evils in this world and a danger most Christians choose to ignore or explain away. Serpents come in many guises and so does play.

The long reach of play

The idea that play is involved in religion and the many cultural and behavioral attainments of our species, including all the diversity, creativity, and technological advances, is not new; neither is the importance of play in education and development of children. Plato discussed the latter in *The Republic*, as have many other scholars. Perhaps the most famous proponent of play in human culture was the Dutch historian Huizinga (Huizinga, 1955), whom I quoted at the beginning of my book on play:

Now in myth and ritual the great instinctive forces of civilized life have their origin: law and order, commerce and profit, craft and art, poetry, wisdom, and science. All are rooted in the primeval soil of play.

(Huizinga, 1955. p. 5)

Of course, this is just a claim, but it has as much support, perhaps, as many other claims. It is also an idea seriously considered today by diverse researchers. In 2012 a conference on *Play, Ritual, and Belief in Animals and in Early Human Societies* was held at the McDonald Institute for Archaeological Research at Cambridge University that brought together archaeologists, psychologists, animal behaviorists, anthropologists, art historians, and classicists to discuss the role of play in the evolution of human culture. In the resulting publication, one of the editors explicitly stated that work on animal play inspired the conference and resulting book (Morley, 2018a). This book is a fine source for many ideas on the roles that play has had in many aspects of human behavior (Renfrew, Morley, & Boyd, 2018). Experts on ancient societies in Asia, Europe, Africa, and the Americas cover topics such as pretense, pretend play, games, learning, creativity, art, dance, masks, drama, narrative, architecture, statuary, sacred play, mimesis, feasts, and other communal activities. I refer readers to this book to find many detailed examples as well as theoretical and conceptual discussion of the role of play in early human civilizations. Of course, disagreements

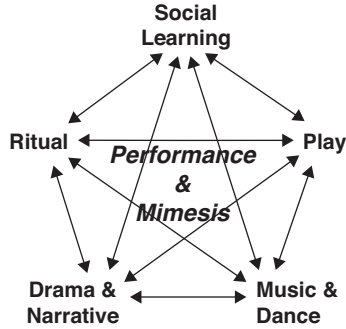


Figure 7.1 The “Pentagram of Performance,” depicting how the human behaviors of play, ritual, social learning, music and dance, and narrative and drama are fundamentally interrelated in cognitive capacities that underlie them, the ways in which they function, the ends that they achieve, and their mutual reliance in achieving these ends

Source: Modified from Figure 1 in Morley (2018b)

on the nature of play and ritual are present in that volume as well as on the topics in this one, but important consensus was reached despite the many fields and experts involved (Morley, 2018b). A summary figure of the relationships among the many topics covered is in Figure 7.1.

After Huizinga, two other major writers on play write large in the human arena should interest readers of this book. Brian Sutton-Smith, a prolific play and folklore psychologist, wrote a seminal book, *The Ambiguity of Play* (Sutton-Smith, 1997), wherein he developed seven major rhetorics of play and how play is envisioned by scholars in various divisions of psychology, education, the arts, humanities, and social sciences. In his posthumous *Play for Life* (Sutton-Smith, 2017), the deep, dark, risky, sad, fearful, and disgusting aspects of play are brought out along with its positive values. Play is indeed a complex affair. Thomas Henricks, a sociologist, builds on the work of Huizinga and Sutton-Smith and relates play to the work of major scholars in sociology, anthropology, history, ritual, and the humanities in *Play and the Human Condition* (Henricks, 2015c). He concludes, “We play in order to distill our personal capabilities and to test them by means of specific challenges” (p. 226). Play can thus be a major way in which our ancestors met and solved the challenges of social life detailed in this book.

But what is play?

Play, although studied intensively in human and nonhuman animals (Bekoff & Byers, 1998; Bruner, Jolly, & Sylva, 1976; Pellegrini, 2009, 2011; Smith, 1984, 2010), has been notoriously difficult to define for several reasons. One is that play comprises a very diverse set of phenomena and can be solitary, social, and with or without objects or structures. Definitions that include aspects found primarily in social play, such as

specialized signals, are thus invalid. Another, and perhaps more important, factor is that play seemed so easy to spot that definitions were highly anthropocentric and anthropomorphic. Indeed, until recently play researchers thought play was almost, or exclusively, the province of mammals and some birds (Bekoff & Byers, 1981; Fagen, 1981). Definitions frequently did not have objective or clear criteria. To remedy this, I combined many of the attributes of play in five sets of criteria, all of which had to be satisfied before we could confidently label a behavior as play (Burghardt, 1999). An extended rationale was developed in my book on play (Burghardt, 2005), and they are now applied extensively and have been used to identify play in animals as diverse as turtles, lizards, frogs, spiders, wasps, fish, and crocodilians (Burghardt, 2005, 2014).

A compact listing of the criteria would go like this. Play (1) is incompletely functional in the context in which it appears, (2) is spontaneous, pleasurable, rewarding, or voluntary, (3) differs from other more serious behaviors in form (e.g., exaggerated) or timing (e.g., occurring early in life before the more serious version is needed), (4) is repeated, but not in abnormal stereotypic form (e.g., distressed rocking, pacing), and (5) is initiated in the absence of acute or chronic stress, sometime referred to as a relaxed field, which may include boredom and mood conflicts. The criteria do not necessitate knowing the subjective or motivational state of the animal, which is often very difficult in many species, let alone people. The criteria seem to cover accepted examples of all three kinds of play (locomotor/rotational, object/predatory, and social) typically studied in animals (Burghardt, 2005; Fagen, 1981) as well as the additional types sometimes viewed as limited to humans and have been rather widely employed. There are additional criteria often applied to social play such as play signals (symbols?), self-handicapping, role reversals, and meta-communication (Bateson, 1956; Bekoff, 1972, 1995).

Additionally, humans, especially, engage in pretense and pretend play, sociodramatic play, humor, and elaborate rule-based games (although much animal rough and tumble play, play fighting and chase games, etc. involve “rules” that, when violated, can lead to punishment or play cessation). In fact, mental play is something humans are experts at, as we do not need to physically operate on the environment to try out, or play with, various scenarios and outcomes (Burghardt, 2005), and thus play can be a source of innovation, creativity, and scientific experimentation (P. Bateson, 2014; P. Bateson & Martin, 2013; Burghardt, 2015; Kuczaj, 2017). Communication is essential to social play, and intentionality may be also – play may be an essential evolutionary window on understanding these phenomena and even language itself (Bekoff & Allen, 1998; Call & Tomasello, 2007; Liebel & Call, 2012; Palagi et al., 2016). Play has also been advanced as an important means by which values of cooperation, fairness, and morality are developed and transmitted (Bekoff, 2001; Bekoff & Pierce, 2009; Durand & Schank, 2015; Palagi, Cordoni, Demuru, & Bekoff, 2016; Schank, Burghardt, & Pellis, 2018). Play may have a role in reducing xenophobia and intergroup aggression (Antonacci, Norscia, & Palagi, 2010). Adult play in both nonhuman primates and humans (including artistic and scientific freedom) occurs more often in less hierarchical, more egalitarian social systems (Burghardt, 2013; Ciani, Dall’Olio, Stanyon, & Palagi, 2012; Pellis & Iwaniuk,

2000; Reinhart et al., 2010). Social play in all its guises involves ambiguity, shifting boundaries, and trust (Seligman & Weller, 2012). These references rely largely on nonhuman animal, theoretical, and modeling studies. The fact that these topics are related to the major claims for human distinctiveness and our evolution as a species also supports the claims of the importance of play in human evolution.

Although many aspects of play are not amenable to neuroscientific study, some important work has been done. An excellent volume is available (Pellis & Pellis, 2009) along with reviews and experimental studies that appear regularly (Achterberg et al., 2016; Burleson et al., 2016; Trezza, Baarendse, & Vanderschuren, 2010; Vanderschuren & Trezza, 2014). These and other studies are beginning to unravel both the functions of play in specific contexts and the neural substrates involved. Play also involves emotions, not just cognitive processes, and approaches focusing on the latter are bound to founder in understanding the human species (Panksepp, 1998; Panksepp & Biven, 2012). Furthermore, the phylogeny and evolution of play, with all the comparative data becoming available, have now led to more sophisticated ways of understanding how and why play evolved the way it has (Burghardt & Pellis, 2019; O'Meara, Graham, Pellis, & Burghardt, 2015; Pellis, Burghardt, Palagi, & Mangel, 2015).

There have been numerous attempts to develop broad theoretical understandings of play by many leading scholars (reviews in P. Bateson, 2011; Burghardt, 2005; Henricks, 2015a, 2015b, 2015c). Most theories are focused on a specific function (Spinka, Newberry, & Bekoff, 2001), but given the great diversity of play no single function should be widely applicable. More focused micro-theories are a better bet (Burghardt & Pellis, 2019), given the many different types of play. I developed a Surplus Resource Theory approach in which play is favored when animals have surplus energy, time, and behavioral (including experiential/educational/mental) resources to engage in behavior not immediately accomplishing a functional end (Burghardt, 2005). Thus, animals who have more complex behavioral repertoires will be more likely to show variants of them akin to genetic changes involving mutation, recombination, reordering, suppressing, duplicating, etc. (Burghardt, 2005; Fagen, 1981). Such behavioral changes may themselves become genetically fixed via mechanisms such as the Baldwin effect (Baldwin, 1896; Weber & Depew, 2003; West-Eberhard, 2003), which has now been shown to be applicable to social learning in fruit flies (Danchin et al., 2018; Whiten, 2018)! In addition, play evolution begins as byproducts of other processes (primary play), gains a role in maintaining or improving skills (secondary play), and may eventually become tertiary play. The latter facilitates brain and neural development, complex sociality, novel behavior, cultural transmission, creativity, and the transformation of physical behavior (e.g., gestures) to more interior or mentalized forms (e.g., verbal language) (Huffman, 1996; Huffman, Leca, & Nahallage, 2009; Nahallage, & Huffman, 2008; Tomasello et al., 1997). Thus, from simple beginnings and surplus resources, complex play and its offshoots can develop and evolve (Auerbach, Kanarek, & Burghardt, 2015; Burghardt & Pellis, 2019).

This is a highly compacted version of my approach to play, but the ways in which it intersects with the topics in this book should begin to be clear. As an example, I will briefly discuss ritual and religion, eventually returning to the story of Jamie Coots.

Ritual, religion, and Bellah

Fascination with the topic of the origins of religion goes back centuries, but perhaps became very common in the late nineteenth century. Interest largely faded and the contributions ignored, but the topic was again brought back in the now active field of evolutionary and cognitive psychology, in the form of the Cognitive Study of Religion (CSR), represented by numerous edited books (e.g., Bulbia et al., 2008; Feerman, 2009), monographs (e.g., Wilson, 2002), and the journal *Religion, Brain and Behavior*. I will not comment on this work here, except to say that play is virtually never mentioned (true also in an otherwise admirable recent critique of CSR by Czachesz, 2018). Instead I will discuss a seminal attempt to deal with our current understanding of early religious traditions imposed on human evolution. This is the book by the noted sociologist Robert Bellah (Bortolini, 2015) titled *Religion in Human Evolution* (Bellah, 2011). It treats religion, as the subtitle reads, “From the Palaeolithic to the Axial Age,” and thus includes much of the time period this volume covers.

Elsewhere I have developed an argument that ritual shares many similarities with play and that the ethological concept of ritualization shows how play can lead to ritualistic behavior (via both biological and cultural evolution and their interaction) and eventually lose its playful elements (Burghardt, 2018). This extended treatment cites Rossano’s approach to ritual very favorably, and discusses many others in the field of ritual studies. I refer you to his chapter for discussions of ritual and its roles. However, I argue that before there was ritual there was play. Thus, if ritual made us human, then play is even more basal. Ritual is central to religious activities, of course, and Bellah outlines an approach through his rich reading in biological evolution and detailed analysis of tribal, archaic, and axial religions using archival resources and anthropological studies of extant or recent hunter-gatherer societies.

Bellah uses play as a key process in his work on religion in human evolution. In the first paragraph of his conclusion chapter he writes:

In the course of completely rewriting chapter 2, “Religion and Evolution,” I discovered the importance of play among mammals and the extraordinary way in which play in animals provided the background for the development of play, ritual, and culture among humans. So play, though discovered last, did get in quite early in this book, but then is largely ignored through the whole trek from tribal to axial religions. Play was there all the time, just below the surface, though I didn’t point it out. . . . I will here in the Conclusion try briefly to make up for that deficiency by discussing the importance of play and those things that endanger play in human life.

(p. 567)

Indeed, there is a section in the conclusion chapter labeled “Play, Ritual, and the Early State” that not only summarizes how these interrelate, but also how huge public rituals, perhaps no longer themselves playful, can reinforce the legitimacy of dominant ruling elites in class-divided societies, allowing the elites to play: in the

arts, sports, and preparations for war. So, for Bellah play is a protean concept called on to do considerable intellectual work in the study of religion.

Ironically, for a book on religion that delves deeply into evolutionary biology, Bellah has little use for most students studying the evolutionary and cognitive psychology of religion (CSR) mentioned earlier. This is because they are preoccupied with the presumed functions and adaptive value of religion while ignoring its actual origins and evolution. As he writes in his preface to the book:

What this all means for religion, is that in this book the search is not to find the ways in which religion is adaptive, and thus a good thing, or maladaptive, and thus a bad thing, or even something that developed in a spandrel, a kind of empty evolutionary space, and is neutral with respect to adaptation. I want to understand what religion is and what religion does and then worry about its consequences for the world of daily life. The consequences are enormously important, and the question of whether they are adaptive or not cannot finally be avoided. But adaptations can be found for almost any phenomenon – biologists call them just-so stories. They are not the place to start; the reality of life in the religious mode is where I will begin.

(p. xxii)

Bellah, thus, is not so much concerned with the functions of religion or theology, but in the actual rituals and practices of religion. Interestingly, how he approaches religion mirrors almost exactly my approach to play, which I came to study as an outsider who thought that by focusing on function play researchers were starting at the wrong end, for a bottom-up, not top-down, approach was needed (Burghardt, 1984).

The features of play and ritual that Bellah highlights are applicable to many of the narratives used in other chapters in this book, and thus challenge others to consider them. Here they are, listed concisely: (1) Social play involves intentionality. (2) Social play needs shared attention. (3) Social play involves norms as well as rules. (4) Social play is practice of performance, not an external end. Note that these features are also shared by rituals. (5) Intense rituals can become repetitive, traditional, and almost sacred, even in animals. (6) Thus, rituals, derived from play, are central to proto-religion in human societies. (7) Play, in animals as well as humans, has a role in facilitating cooperation, fairness, and aspects of morality.

Bellah adopts the scheme developed by Merlin Donald (Donald, 1991) to frame his origins story. Although Donald himself may have modified his views I will briefly list the culture typology that Bellah uses.

- *Episodic culture* – found in mammals, especially where social behavior is an immediate short-term response to the environment. Memories of past events lead to concrete episodic event representations, and these are neither abstract nor symbolic.
- *Mimetic culture* – prelinguistic (some animals), can involve dancing, vocalizations (singing), rhythmic synchronized movements, complex forms are rituals.

- *Mythic culture* – involves language, narrative, music, festivals, and rituals. All human cultures have them, but rituals are more resistant to change than myths.
- *Theoretic culture* – dependent on external memory storage involving writing, graphic representations, etc. Developed very gradually from the first millennium BC and needed an alphabetic writing system and analytic reasoning for its own sake, not just for practical problem solving as in agriculture, astronomy, and metallurgy, which were well-established by then.

It is important to note that just as in the evolutionary play scenario of primary to secondary to tertiary play, all four cultural types are retained in theoretic cultures. This is an important message lost on all those who think, like eighteenth-century enlightenment thinkers, nineteenth-century anthropologists (e.g., Frazer, 1890), and modern militant atheists, that science and reason will replace magic, myths, religion, and supernatural beliefs. The French, Soviet, and even Chinese revolutions showed the virtual impossibility of accomplishing this even with the iron arm of state power.

Play provides the resources for ritual, which then become the source of religion. Early religion for Bellah was far removed from how we view religion today. Religion is as diverse a phenomenon as are ritual and play. The idea that play is at the source of many human cultural attainments and institutions is not new, as we have seen. Other writers on the human condition have also been enamored of the role of play in rituals. In a major interdisciplinary symposium on ritualization throughout the animal, including human, world, the ethologist William Thorpe was the only one to invoke play and claimed from his study of birds that play, through ritualization, became symbolic rituals (Thorpe, 1966). A bit later, Clifford Geertz, in the lead off paper in a volume devoted to *Myth, Symbol, and Culture*, published his classic deep play analysis of Balinese cockfighting (Geertz, 1972). More humanist scholars have also been enamored with play (e.g., Turner, 1982) including in religion and theology (e.g., Miller, 1970; Sax, 1995), although their conceptions of play differ, and ignore nonhuman animal play. An exception is Pannenberg, whose book on theological anthropology has extensive discussion of play, animals, and ethology, citing Konrad Lorenz, and went so far as to claim that “representational play finds its perfect form in cult” (Pannenberg, 1985, p. 331). Play, ritual, and religion in childhood have been addressed briefly by Rossano (2010), who discusses a child’s development and use of imagination and pretend play, which provides a vehicle for trying out, or imagining, various alternative scenarios, as I had also discussed in terms of play (e.g., Burghardt, 2005). Evaluating the literature on children and the supernatural, I concluded that “developmental psychology cannot be omitted from understanding religion, ritual, and ideas of gods, souls, and other beliefs. Play may be the evolutionary phenomenon that jump-started the whole process” (Burghardt, 2018, p. 33). So perhaps Rossano will accept this conclusion as well.

Final thoughts

Pretend play, pretense, imagination, and mental play may be at the heart of what makes us human. It all goes back to wondering “what if?” Now largely forgotten, the importance of fictions and “as if” approaches to philosophy was advanced a century ago by a follower of Kant (Vaihinger, 1924). The subtitle of his book *The Philosophy of “As If”* was “A System of the Theoretical, Practical and Religious Fictions of Mankind,” but he included scientific fictions as well. Today, I think he would view most computer and other models of phenomena as fictions, certainly useful, but “as if” constructs nonetheless. The value of childhood play in becoming a naturalist or engineer and developing creative inquisitiveness has long been pointed out (Petroski, 2003; Preyer, 1893), so play’s reach is long indeed.

We cannot go back in time to test whether current long-standing rituals have some connection with play in their origins. One method is to apply recent phylogenetic tools to comparative databases as we are beginning to do with play in the adult nonhuman primates (over 100 species) and would like to do with anthropological data for human cultures (O’Meara et al., 2015; Pellis & Iwaniuk, 1999a, 1999b, 2000; Thierry, Iwaniuk, & Pellis, 2000). However, there is a current ritual practice available for study, and that is the snake handling Pentecostal tradition in the Appalachian areas of the US, as noted in my opening story on Jaime Coots (e.g., Burton, 1993; Hood & Williamson, 2008). Its origins about a century ago are known and its history documented through practitioner writings (Morrow, 2005) and filmed services going back 80 years or more. As noted earlier, risky play is involved in snake handling that even some practitioners acknowledge. What happens during the service is far from the choreographed, solemn, highly stereotyped performance of a mass, confirmation, or many other events. Funerals certainly fit this description in some cases, but then the wild and musical funerals in New Orleans’ African American community underscore the playful elements even in death.

Finally, surplus resources provided the behavioral means for humans to develop many basic behavioral, social, communicative, and mental skills. Surplus material resources also allowed societies to invest vast labor and riches in creating many of the major architectural and ritual sites we still treasure today, be they pyramids in Egypt, medieval gothic cathedrals, or the much more ancient early Neolithic wonders of Göbekli Tepe from over 10,000 years ago. The last words from the final sentence in Trevor Watkins’ analysis of the ritual practices and ceremonial structures of these recently excavated sites provide my coda: “the making and installing of a sculpted stone image may be understood as the making of belief – truly make believe, which is where the social play of children and ritual meet” (Watkins, 2018, pp. 139–140).

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PART II

Prehistory from the perspective of cognitive psychology



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8

THE ORIGINS OF GENERATIVITY

Michael C. Corballis

Generativity, or productivity, refers to the ability to use a few rules to create a large number of structures, or what the German philosopher and linguist Wilhelm von Humboldt (1836/1988) captured more succinctly in the phrase “infinite use of finite means.” It is most commonly invoked in discussions of language, and our capacity to generate an “astronomical variety of sentences” (Hauser, Chomsky, & Fitch, 2002), through the application of rules known as generative grammars. These typically operate through recursive principles, whereby symbols are combined to form structures, which are in turn combined into larger structures, and so on, potentially *ad infinitum*. This leads to what Chomsky has also called “discrete infinity,” our ability to start with a finite number of symbols and create an infinite number of possible utterances.

Hauser, Chomsky, and Fitch propose that the language faculty can be divided into two parts, the faculty of language in the broad sense (FLB) and the faculty of language in the narrow sense (FLN). We share FLB with other species that communicate, but it is FLN that is infinitely generative, and according to Hauser et al. is unique to humans. The invariant rules that exist within FLN, and that generate I-language, also make up what has been called “universal grammar” (UG). In the so-called Minimalist Program (Chomsky, 1995), a single recursive mechanism, called unbounded Merge, may be sufficient to generate all of the structures underlying what Chomsky has called internal language or I-language.

I-language, though, is not a means of communication as such, but is rather a mode of thought that can be *externalized* to create any of the 7,000 languages actually spoken or signed. It is said to have emerged within the past 100,000 years within our own species, perhaps initially in a single individual whom Chomsky (2010) whimsically calls Prometheus. Because no other animal has language, it appears to be a “great leap forward” of some magnitude, violating Linnaeus’ and Darwin’s principle of *natura non facit saltum*: “For natural selection can act only by taking

advantage of slight successive variations; she can never take a leap, but must advance by the shortest and slowest steps” (Darwin, 1859, p. 194).

A number of archaeologists have also endorsed the suggestion of a great leap forward, based on an apparent surge in symbolic artifacts and cognitive sophistication within the past 100,000 years. Tattersall (2012), for example, writes almost with incredulity that:

Our ancestors made an almost unimaginable transition from a non-symbolic, nonlinguistic way of processing information and communicating information about the world to the symbolic and linguistic condition we enjoy today. It is a qualitative leap in cognitive state unparalleled in history. Indeed . . . the only reason we have for believing that such a leap could ever have been made, is that it *was* made. And it seems to have been made well *after* the acquisition by our species of its distinctive modern form.

(p. 199)

Hoffecker (2007) writes similarly, and places the leap even earlier than 100,000 years ago:

Language is a plausible source for the sudden and dramatic change in the archaeological record [after 40,000 ybp] because: (a) it is difficult to conceive of how the system for generating sentences (i.e., syntax) could have evolved gradually, and (b) it must have had far-reaching effects on all aspects of behavior by creating the collective brain.

(p. 379)

According to these views, the origins of generativity lie within the time span of our own species, some 100,000 years or more *after* our species itself is thought to have emerged, at around 200,000 years ago. From a Darwinian perspective this seems implausible. Generativity is a pervasive aspect of human life, incorporating not only language but also mathematics, manufacture, music, and even art, and to suppose that it emerged in a single step is a denial of the principle of *natura non facit saltum*.

Reaction against the great leap

Reaction has come from several quarters. First, some have argued that the archaeological leap was illusory. McBrearty and Brooks (2000) write of the “revolution that wasn’t,” suggesting a more gradual rise in technological sophistication, starting in the Middle Stone Age around 250,000 to 300,000 years ago. Some cave art once attributed to *Homo sapiens* can now be attributed to the Neanderthals (Hoffmann et al., 2018), and accumulating evidence suggests sophisticated technology among predecessors of *Homo sapiens*, including Neanderthal use of wooden tools and fire

technology (Aranguren et al., 2018). In an apparent change of heart, Hoffecker (2018) comments that Neanderthal technology was of a complexity comparable to that of modern hunter-gatherers. Our common ancestry with Neanderthals probably goes back at least 550,000 years (Meyer et al., 2016).

It is also now established that *Homo sapiens* interbred with both Neanderthals and Denisovans, which some have taken to imply that these large-brained hominins must have possessed language (Johansson, 2013; Dediu & Levinson, 2013). Villa and Roebroeks (2014) suggest that the belittling of Neanderthals is a matter of the “human superiority complex,” although it might also be driven by guilt that their demise might have been caused by the invasions of *Homo sapiens* – tantamount, perhaps, to genocide.

Some have also questioned the very existence of universal grammar, supposedly a manifestation of human ascendancy. In a discussion of the vast diversity of present-day languages, Evans and Levinson (2009) concluded that “the emperor of Universal Grammar has no clothes” (p. 438), and Tomasello (2009) has remarked similarly that “Universal grammar is dead” (p. 470). In fairness to Chomsky and colleagues, though, the diversity of languages is not directly relevant, because universal grammar is a property of thought, or I-language, and not of actual languages as spoken or signed. It is also fair to add that, in the view of Chomsky and colleagues, the Minimalist Program reduces universal grammar to the operation of a single operator, Merge, and was perhaps not such a great leap forward after all. In the words of Berwick and Chomsky (2016), “we simply don’t have as much to explain, reducing the Darwinian paradox” (p. 11).

Be that as it may, there is still the question of how universal grammar, or I-language, came about. To Chomsky and colleagues, it remains a fundamental discontinuity between humans and all other species. But once actual language is stripped of the requirements for externalization, such as vocal learning or linearization, the mechanism of I-language may be seen to have quite general application beyond speech or sign language, and may well have evolved much earlier and quite independently. This has led to suggestions as to how it might have arisen in gradual steps, or even continuously, and claim a lineage long preceding the emergence of *Homo sapiens*. Some indication as to how this may have come about comes from an often neglected feature of language – displacement.

Displacement

Displacement is the ability to refer to the nonpresent, and according to Hockett (1960) is one of the “design features” of language. Bickerton (2014) has suggested that it is displacement, rather than the use of arbitrary symbols, that provides “the road into language” (p. 93). Expressive language may therefore have evolved precisely to allow us to share past experiences, future plans, or even the products of pure imagination that are not immediately accessible through the senses. Brinck and Gärdenfors (2003) suggest that future-directed cooperation was especially critical to the emergence of language, and future-directed thinking takes us beyond the

factual and into more speculative realms. The escape from actuality may underlie the emergence of storytelling, which features prominently in the construction of culture and even religion (Boyd, 2009). The importance of displacement as critical to language and its evolution is increasingly recognized (e.g., Gärdenfors & Osvath, 2010; Hurford, 2007).

Displacement applies not only to communication about events not in the present, but also to having such thoughts in mind. This implies mental time travel (Suddendorf & Corballis, 1997, 2007) – the mental replaying of past events, the imagining of future events, or even the imagining of fictitious events that need not have any basis in reality. Language, then, provides us with the capacity to share such events, but it is the mental events themselves that provide the material. As Dor (2015) put it, language is “the instruction of imagination.” Mental time travel might then be considered to be, at least in part, the basis of I-language, with externalization the mapping of expressive language onto our mental travels. By the same token, mental time travel might lie at the core of generativity.

Many (including myself) have argued that mental time travel is itself unique to humans, which might explain why language itself seems to be an exclusively human faculty. In this view, other animals are effectively stuck mentally in the present. Tulving (1972) has long argued that episodic memory, the capacity to consciously replay the past, is restricted to our own species, and Suddendorf and I extended this proposition to mental travels both forward and backward in time (Suddendorf & Corballis, 1997, 2007). This was anticipated by Donald (1991), who wrote that “The lives of apes are lived entirely in the present” (p. 149), and much earlier Kohler (1917/1921), based on his studies of problem solving in chimpanzees, wrote that “the time in which chimpanzees live is limited in past and future” (p. 272). More recently, though, the idea that mental time travel is uniquely human has been strongly challenged by ethologists and animal psychologists, who have offered behavioral evidence for episodic memory and/or future thinking in nonhuman animals. These include great apes (Janmaat, Polansky, Ban, & Boesch, 2014; Martin-Ordas, Haun, Colmenares, & Call, 2010), meadow voles (Ferkin, Combs, delBarco-Trillo, Pierce, & Franklin, 2008), rats (Wilson, Pizzo, & Crystal, 2013), ravens (Kabadayi & Osvath, 2017), scrub jays (Clayton, Bussey, & Dickinson, 2003), and even cuttlefish (Jozet-Alves, Bertin, & Clayton, 2013).

Behavioral evidence can be ambiguous, though, and can sometimes be explained in terms of association or trial-and-error learning. The elusive ingredient is what Tulving (1985) called “autonoesis” – the sense of placing oneself in different places and times and examining one’s own experience, which is difficult to assess in animals without language. A closer approximation to autonoesis may come from recordings of brain activity itself, and the correspondence between humans and animals in activity evoked under circumstances likely to incorporate mental time travel. A key structure is the hippocampus, and it was evidence based on hippocampal activity that caused me to change my opinion and argue that mental time travel, and perhaps generativity itself, may have a long evolutionary history (Corballis, 2013; but see also Suddendorf, 2013, for a contrary opinion).

The role of the hippocampus

In humans, the hippocampus plays a critical role in both episodic memory and episodic future thinking. People with destruction of the hippocampus are unable to recall past events or imagine future ones (Corkin, 2013; Tulving, 2002; Wearing, 2005). Brain imaging also shows the hippocampus to be active when people are asked to recall previous episodes, to imagine future ones (Addis, Cheng, Roberts, & Schacter, 2011), or even to construct fictitious ones (Hassabis, Kumaran, & Maguire, 2007). This is not to say that representations are stored in the hippocampus; episodic memory activates many regions of the brain besides the hippocampus, including the angular gyrus, the medial frontal cortex, and the posterior cingulate (Rugg & Vilberg, 2013). The hippocampus appears to be necessary, though, for what has been termed “scene construction” (Maguire, Intraub, & Mullaly, 2016), the drawing together of dispersed information for autonoetic inspection. Without that construction, individuals have no personal sense of past or imagined events, but may well have access to general knowledge (noetic information).

It has long been known that the hippocampus in animals plays a role in spatial location, seemingly a function having little to do with memory. Recordings from single cells in the hippocampus of the rat record the animal’s location in space, and as the animal moves about in some environment different cells become active. They are known as “place cells,” and have led to the notion of the hippocampus as a “cognitive map,” or a kind of internal GPS system (O’Keefe & Nadel, 1978). It has become clear, though, that place cells do play a role in memory, and may even provide the basis for scene construction and mental time travel generally.

Experiments have shown that hippocampal activity may persist in short-wave ripples (SWRs) after the animal has been removed from a spatial environment, such as a maze, and these ripples map out trajectories in the environment. These trajectories are sometimes “replays” of trajectories previously taken, sometimes the reverse of those trajectories, and sometimes trajectories the animal did not take, including some that may be anticipations of future trajectories. These observations from animal studies suggest at least limited mental access to past and future events, and perhaps even to imagined events unrelated to future planning. Reviewing the evidence, Moser, Rowland, and Moser (2015) write that “the replay phenomenon may support ‘mental time travel’ . . . through the spatial map, both forward and backward in time” (p. 6).

Moser et al. also summarize evidence that place cells in the rat hippocampus respond not only to specific locations, but also to features of environments they have visited, such as odors, touch sensations, and the timing of events. Similar associations seem to be tagged to place cells in the human hippocampus. In one study, human patients about to undergo surgery had electrodes implanted in cells in the medial temporal lobe, in an attempt to locate the source of epileptic seizures. They were given the task of navigating a virtual town on a computer screen, and delivering items to one of the stores in town. They were then asked to recall only the items, and not the location to which they were delivered. The act of recall, though, activated

place cells corresponding to that location, effectively mirroring the replay of place-cell activity in the rat brain (Miller et al., 2013).

Recordings from the rat hippocampus also reveal what have been termed “time cells,” which respond in coordinated fashion to code the relative times in which events have occurred in the past. The pattern itself changes over time as the temporal context changes (Eichenbaum, 2017). This can be observed experientially in our own memories of when things happened, gradually losing immediacy and detail, both spatial and temporal. The hippocampal coding of space and time in both humans and animals suggests that episodic mental travel may long predate human evolution.

Expanding horizons

Experimental limitations mean that the evidence from the rat covers short durations of not more than a few hours, whereas human episodic memories can go back years, if not decades, suggesting that the capacity for mental travels expanded in human evolution. A critical era was the Pleistocene, when an emergent hunter-gatherer pattern favored a lifestyle extended in both space and time (Gärdenfors & Osvath, 2010). There were long delays between the acquisition and the use of tools, as well as geographical distance between the sources of raw material for tools and killing or butchering sites. Migration itself would have added to demands of time, space, and cooperation. The hunter-gatherer lifestyle involved frequent shifts of camp as resources were depleted, forcing the group to move on to another more abundant region – a pattern still evident in present-day hunter-gatherers (Venkataraman, Kraft, Dominy, & Endicott, 2017).

Migrations also increased in scale during the Pleistocene, with dispersals of early *Homo* from Africa reaching the Loess Plateau in China by 2.1 million years ago (Zhu et al., 2018), and other widespread regions in Europe and Asia in the previous millennium (Kappelman, 2018). Later waves of migration of *Homo sapiens* out of Africa began from about 120,000 years ago (Timmermann & Friedrich, 2016), eventually inhabiting most of the globe. Of course, humans are not entirely alone in undertaking large-scale migrations. Birds, whales, wildebeest, and even butterflies migrate vast distances, but these are largely seasonal (as are some human migrations, especially of the wealthy) and based on instinct rather than planning. The caching behavior of birds is perhaps a better example. The Clark’s nutcracker is said to cache some 33,000 seeds in around 7,000 locations every fall, and relies on spatial memory to recover them over the winter (Kamil & Balda, 1985). Evidence from scrub jays, moreover, suggests that caching behavior involves mental time travel both forward and backward in time (Clayton et al., 2003). Even so, the human ability to recapture the past and imagine the future, at least with respect to time, probably exceeds that of any other living animal.

Perhaps the ultimate stretch is the ability to imagine events outside of the lifespan. Historical records have allowed us to create stories and movies reconstructing events long in the past, and even to imagine ourselves as spectators. Physicists have even dared to envisage the origins of the universe. Life is also imagined after death. Pettitt

(2018) notes that even chimpanzees follow certain *mortuary behaviors* on finding a dead conspecific, including staying by the body for many hours, giving alarm calls, and showing signs of grief, as though aware of the permanence of death. The parallels with observation of human reactions to death, he suggests, “are striking” (p. 6). In humans this is further transformed into burial and rituals associated with it, and in the modern world most of these rituals seem to have to do with “transforming the deceased into some form of afterlife” (p. 6). Evidence for the deliberate disposal of corpses, implying a sense of one’s own mortality, has been dated from around 600,000 to 300,000 years ago (Egeland, Domínguez-Rodrigo, Pickering, Menter, & Heaton, 2018). Explicit notions about life after death, though, probably depended on the emergence of propositional language and the formation of religions, which invite us to imagine a life after death, and create vivid scenarios of heavens and hells.

Toward generativity

Mental time travel in humans, whether based on the re-creation of past events, the imagining of future ones, or the creation of fictitious ones, is clearly generative, in that we can produce new combinations of ingredients. This can be demonstrated experimentally by having people identify a person, a place, and an object from each of previous memories of episodes, and then presenting the same elements from different memories and asking them to generate possible future memories from the new combinations. Brain imaging revealed activity in the hippocampus in both the replaying of the past events and the imagining of the future ones, with connections to other parts of the brain, including medial parietal and cingulate cortex, and medial prefrontal cortex (Martin, Schacter, Corballis, & Addis, 2011). Also activated was the entorhinal cortex, adjacent to the hippocampus, which plays a role in modulation of hippocampal firing, and adds significantly to the generation of different representations.

Cells in the entorhinal cortex of the rat respond to fields laid out in grid patterns, and different grid-cell modules are dedicated to different geometric aspects of the environment and its relation to the animal’s location. These various properties allow rapid adjustment of the internal map to accommodate changes in viewing angle, relation to contours, and zooming. One set of grid cells codes for head direction, essentially calibrating which way the animal is facing. Brain imaging shows that as people navigate a virtual environment, hippocampal activity peaks in 60-degree steps, concordant with the hexagonal layout of grid-cell receptive fields (Doeller, Barry, & Burgess, 2010). The adjustment of orientation in imagined space is illustrated in a classic experiment in which patients with left *hemineglect*, a condition in which damage to the right hemisphere results in failure to attend to objects or events on the left side of space, were asked to imagine themselves in the Piazza del Duomo in Milan. They were asked first to imagine themselves at one end of the square facing the cathedral, and to indicate the landmarks they could identify. They systematically neglected those on the left. When then asked to imagine themselves at the cathedral end, facing the other way, they systematically neglected those they had previously identified, now on the left, and identified those they had previously

neglected, now on the right (Bisiach & Luzzatti, 1978). This is a striking demonstration not only that spatial orientation is highly flexible even in imagination, but also that spatial deficits are manifest in imagined as well as in perceived space.

Grid cells also modulate spatial scale, such that different levels of spatial resolution are represented along the axis of the hippocampus, ranging from a more detailed, close view at one end toward a broader, more distant view at the other. In the rat, the dorsal end operates within a region of about 1 meter in width, while at the rostral end the width is about 10 meters (Kjelstrup et al., 2008). This arrangement allows for zooming, which is ubiquitous in human spatial understanding; we can locate ourselves in the immediate environment, such as an office, or zoom out to understand where we are in a building, a city, a country, or even a world map.

We can also zoom in on the imagined past or future, perhaps imagining being in a particular café in Paris, then zooming out to locate the café in that city, and the city in the country. Variations in scale may apply also to our understanding of the structure of events in the world as well as simply to spatial awareness. In one study (Collin, Milivojevic, & Doeller, 2015), people were shown sequences of four videos of different events, along with narratives describing the events. At one level, narratives were linked to each video, encouraging attention to individual details. At the next level, narratives linked a pair of videos, and at the final level a narrative linked all four videos. As the people processed these narratives, activation in the hippocampus progressed from the posterior to the anterior end as the scales of the narrative shifted from small and detailed to larger and more global. This shift probably occurs when reading a novel, with specific information registering page by page, but with a more global understanding forming during reading and later remembering the story.

The entorhinal grid system appears to operate in modular fashion, in which the combinations of just a few modules can generate a vast number of patterns of activity in the hippocampus, because grid modules can assume different levels. Moser and her colleagues write, “The mechanism would be similar to that of a combination lock in which 10,000 combinations may be generated with only four modules of 10 possible values, or that of an alphabet in which all words of a language can be generated by combining only 30 letters or less” (p. 11). This combinatorial system may apply across time as well as space, providing for the “hierarchical organization of space, time and [episodic] memory” (Collin, Milivojevic, & Doeller, 2017) – and no doubt of imagined future episodes as well. In short, the mechanism appears to be both generative and hierarchical.

Generative thought, then, probably derives from the spatial understanding that evolved in animals that move and must locate themselves in space and time. It is in the very nature of movement that things change – location, direction, and the ongoing commerce of events, as well as the need to understand at different levels of scale. It is also adaptive to accommodate the fact that things change, often in unpredictable ways, so moving organisms need to record the past and, more importantly perhaps, anticipate possible futures. It is, I suggest, the extraordinary flexibility of spatial imagination that underlies the generativity of language itself.

Chomsky may well have been correct, then, in identifying an aspect of thought, which he called I-language, that is antecedent to communicative language itself. The account given here is that this aspect is not unique to humans, as claimed by Chomsky and colleagues, but goes far back in the evolution of moving animals. What humans have evolved is the capacity to share our mental travels, using language.

Language as communication

Our ability to communicate our mental imaginings through language, though impressive relative to other forms of animal communication, is by no means perfect, and depends to a large extent on the implicit sharing of thoughts prior to any explicit utterance. Scott-Phillips (2015) notes that language is *underdetermined*, in that words as uttered or signed are themselves seldom if ever sufficient to specify precise meaning – except perhaps in the case of meticulously worded legal documents. This can be partially illustrated through the phenomenon of *polysemy*, the fact that many words have multiple meanings, and speakers and listeners must implicitly agree on the intended meaning. The English word “set,” for example, can serve as verb, adjective, or noun, and my dictionary identifies 105 different meanings.

Theory of mind

More generally, normal language depends on *theory of mind*, the ability to infer what’s in the minds of others, and infer that they know what’s in your mind. This was perhaps first pointed out, albeit in rather convoluted fashion, by the philosopher Paul Grice (1989):

He said that P; he could not have done this unless he thought that Q; he knows (and knows that I know that he knows) that I will realize that it is necessary to suppose that Q; he has done nothing to stop me thinking that Q; so he intends me to think, or is at least willing for me to think that Q.
(pp. 30–31)

Scott-Phillips suggests that it is this underdeterminacy that makes language unique to humans. On this view, then, the uniqueness of language lies not so much in the symbolic nature of underlying thought, as proposed by Chomsky, as in our ability to read each other’s minds, and so convey our thoughts, often by coaxing ongoing trains of thought rather than spelling them out in explicit detail.

Gestural origins

Sometimes understanding does not involve language at all. Scott-Phillips (2015) gives the example of a customer in a coffee shop, catching the attention of a waiter, and tilting his coffee cup in a stylized way. The waiter comes over and fills his cup. Here, the gesture is underdetermined, but the customer and the waiter each know

what's in the mind of the other. Scott-Phillips refers to this kind of communication as “ostensive-inferential” – ostensive because it involves an act of showing, and inferential because it requires an act of interpretation. People carry out many such acts, such as shrugging, pointing, and raising eyebrows, but the most complex form is language itself, whether spoken or signed.

It is by no means clear that ostensive-referential communication is unique to humans. In an extensive study of chimpanzees in the wild, Hobaiter and Byrne (2011) recorded over 4,000 instances of their gestures, with at least 66 different kinds of gesture. Their meanings, though, were somewhat loose and ambiguous, and dependent on context. In short, they appeared to meet Scott-Phillips' definition of ostensive-inferential, and indeed of underdeterminacy. In a wider review, Byrne, Cartmill, Genty, Hobaiter, & Tanner (2017) list 84 different communicative gestures arising from the studies of great apes' gestures, and note that they are goal directed and intentional, unlike most primate calls. And given the ostensive nature of these gestures, it may well be that communicative language in humans itself originated in bodily gestures rather than in animal calls, which tend to be relatively fixed, and lacking in generativity.

Gestural language, as in modern signed languages, is itself an illustration of generativity dependent on spatial understanding. An early manifestation in human development is pointing, described by Colongesi, Stams, Koster, and Noomb (2010) as “the royal road to language.” Although it has been argued that apes do not point, a recent study shows both chimpanzees and bonobos easily able to point to locations where food was hidden, and also to cease pointing when the food was removed from the location (Lyn et al., 2014). Pointing in apes, though, seems designed not so much to share information as to make requests (Tomasello, 2008).

A more advanced form of bodily communication is pantomime. At least some of the gestures listed by Byrne et al. (2017) seem to have mimetic qualities, and other instances of miming in great apes have also been reported. For example, Russon and Andrews (2001) identified 18 different pantomimes produced by orangutans in a forest-living enclave in Indonesia; 14 were addressed to humans and 4 to fellow orangutans. These included mimed offers of fruit, enacting a haircut, and requests to have their stomachs scratched by scratching their own stomachs and then offering a stick to the prospective scratcher. A chimpanzee in the wild watched her daughter trying to use a stone to crack a nut, and then enacted the operation to show her how to do it properly (Boesch, 1993). Tanner and Perlman (2017) also note that gorillas combine gestures in sequence creatively and interactively, although this seems to have more to do with play and personal display than with propositional communication, and may be the origin of music and dance rather than language itself.

Back to the Pleistocene

True pantomime, though, probably emerged during the Pleistocene, as our hominin forbears evolved to become fully bipedal, freeing the hands from locomotion. The switch from a forested habitat to the more open savanna led to more cooperative

activity, the so-called “cognitive niche” (Pinker, 2010), as an adaptation to the more dangerous and uncertain environment. Donald (1991) suggests that what he calls “mimetic culture” evolved with the emergence of our ancestor *Homo ergaster* from around 1.9 million years ago. Life was more peripatetic, including expeditions to find sustenance and migrations to new territories, eventually scattering our species all over the globe. The sharing of mental travels in space and time emerged as a strategy for relaying information about actual or planned foraging expeditions (McBride, 2014). Brain size increased dramatically with the emergence and subsequent development of the genus *Homo*, which might be taken as evidence of selection for more complex communication.

As suggested earlier, mental time travel itself probably expanded in scope during the Pleistocene, and this would have increased the pressure toward more effective and detailed communication. Gärdenförs (2014) suggests that communication became more complex in the context of planning for future goals, requiring elaboration from single words to combinatorial structures necessary for cooperative action, and also for the development of “narratives, particularly gossip.” Language itself expanded beyond the individual sentence to narrative, including culturally important means of expression such as storytelling, legend, and myth (Barnard, 2013). Following Bickerton (1990), Gärdenförs suggests that communication developed to the level of protolanguage in *Homo erectus*, reaching full grammatical structure only in *Homo sapiens* – although as already mentioned the Neandertals and Denisovans may also have been capable of grammatical language (Dediu & Levinson, 2013; Johansson, 2013). Pantomimic communication, minimally evident in great apes, probably expanded during the early Pleistocene (Donald, 1991), before conventionalizing and grammaticalizing into modern language – whether signed or spoken. Enhanced communication would also have allowed mental time travels to be shared, so that the memories and plans of others are incorporated into our own, yet further increasing the demand for mental time travels. In short, communication efficacy and mental time travel coevolved in an expanding spiral.

So to speak

According to this scenario, speech may give a misleading impression of how language and generativity evolved. Just as generativity emerged from the understanding and manipulation of spatial information, so language emerged from the spatiotemporal information relayed by gesture and mime. In the course of time, though, communication would have lost much of its iconic aspect, becoming simplified and more efficient. This occurs even within signed languages, and is known as “conventionalization” (Burling, 1999). But speech itself may have been an endpoint in the move toward conventionalization, with largely arbitrary symbols eventually replacing mimes, and increasingly maintained through social learning. The arbitrary nature of speech may lend itself more easily to the generation of new terms and the formation of abstract concepts, but it loses the immediacy and vividness of mime. And people still use mimetic gesture to augment speech.

But speech itself can be conceived as a gestural system, comprising movements of the lips, the larynx, the velum, and the blade, body, and root of the tongue (Studdert-Kennedy, 2005), with sound added to render these semi-invisible gestures accessible to the audience. This system again frees the hands for other activities, such as carrying things and using tools, and is more energy-efficient than pantomime or gesture. Even so, our speech is normally punctuated by manual and facial gestures that can do much to augment meaning and add emotional content. Of course, the evolution of communicative language did not end with speech. Writing and the printing press, and more recently electronic communication, vastly increased the range of communication over time and space. With the advance of keyboards large and small, manual gesture may once again become the primary means of communicating.

Summary and conclusion

Generativity is a commodity not restricted to humans, nor to human language. At the most general level it is a feature of the biological system – there can be no more generative phenomenon than evolution itself, with an estimated 8.7 million species on earth. Generativity also arises within organisms, as they cope with the exigencies of life on a variable planet. Movement around the planet creates pressures of location, memory, planning, and control. In these respects, humans are no different from many other moving animals, with brains adapted to the understanding of location and the integration of space and time.

The main theme of this chapter is that internal representations of space and time are at the heart of mental function, enabling us to simulate past and possible future experience, and invent scenarios that may have to do with planning or creativity. As primates forced to migrate and adapt to new territories, humans and their hominin predecessors expanded their mental travels in time and space, with the capacity to conjure scenarios beyond the immediate present. With the emergence of the genus *Homo* from around two million years ago, it also became adaptive to communicate these mental scenarios, as survival depended on cooperation. On this view, the distinctiveness of language resides, not in a generative mechanism unique to human thought, but rather in the development of communicative technologies whose generativity resides primarily in what is communicated rather than in the technologies themselves.

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9

THREE STAGES IN THE EVOLUTION OF HUMAN COGNITION

Normativity, recursion, and abstraction

Ceri Shipton

Introduction

The human mind is likely the most complex in the animal kingdom, and it differs from those of our nearest great ape relatives in a number of ways (Suddendorf, 2013). Popular literature is replete with “prime mover” explanations of what the most important of these might be. But the archaeological record should caution us against fixing on any one particular aspect of our cognition, as our ancestors passed through many distinct phases of behavior since the divergence of our lineage and that of our closest living relatives (chimpanzees and bonobos). The premise adopted here is that understanding the evolution of our cognition requires a gradualist approach, looking at the cognitive implications of each major period of human behavior and understanding the broader adaptive context in which these behaviors emerged. This chapter examines the last one million years of human evolution and argues that each of three major archaeological periods, the late Acheulean, the Middle Palaeolithic, and the late Palaeolithic, are characterized by the cumulative addition of three unique components of our cognition: normativity, recursion, and abstraction, respectively. While the selective conditions operating during each period and the cognitive traits that resulted are presented here as causally linked, they are essentially two independent hypotheses for each period with the link between them not integral to their validity. In an evolutionary account the order of the appearance of traits is critical, and here it is suggested that normativity preceded recursion, while both preceded abstraction.

Previously we have argued that a propensity for imitation and even overimitation (specifically automatic causal encoding (Rossano, 2017)) characterized the behavior

of Acheulean hominins (Nielsen, 2012; Shipton, 2010, in press-a; Shipton & Nielsen, 2015). It is this trait that gave rise to the extraordinary ~1.5 million year duration of the Acheulean, the longest of all prehistoric cultural entities. Acheulean hominins were such excellent social transmitters that they spread their characteristic tool forms over much of Africa, the Middle East, Europe, and India (Shipton, in press-b), making the Acheulean perhaps the most ubiquitous of all prehistoric cultures.

Such robust social transmission may have been selected for in the context of medium to large carcass acquisition. In the preceding Oldowan period, hominins were acquiring medium to large mammal carcasses (Ferraro et al., 2013; Pickering & Domínguez-Rodrigo, 2006) – animals that were too large to be torn apart by hand, as chimpanzees do with their small primate prey, but instead required stone tools for their butchery. One of the consequences of acquiring large animal carcasses is that there is excess meat, which can be shared to maximize fitness benefits (Kaplan, Hill, Lancaster, & Hurtado, 2000; Winterhalder, 2001). Oldowan sites show the repeated import of carcass elements, perhaps for sharing (Ferraro et al., 2013). Male chimpanzees who share meat with females tend to have more copulations with those females (Gomes & Boesch, 2009). Parceling up meat and making the tools used to do this were likely integral to the fitness of early *Homo*. These hominins were probably also using stone tools for a variety of other purposes, including slicing meat into easily chewable strips (Zink & Lieberman, 2016) and making projectiles with which to hunt (Roach, Venkadesan, Rainbow, & Lieberman, 2013). Tools made of other materials that have not survived were no doubt also integral to the lifeway of early *Homo*, but these remain more conjectural for the time being. Toolmaking and tool use seem to have been such important skills that a robust social transmission mechanism, imitation, evolved in order that individuals could reliably acquire technologies.

Normativity in the Acheulean

Immediately prior to the emergence of the Acheulean, the large bodied species *Homo erectus* appears first in East Africa, and very soon spreads beyond Africa (Ferring et al., 2011). A reduction in abdomen size indicates *Homo erectus* had a more nutrient dense diet than earlier hominins, likely because it was eating more meat (Aiello & Wheeler, 1995). Acheulean butchery tools, such as the handaxe, are more elaborate than those of the Oldowan, with one of the key advantages being the long, durable bifacial cutting edge that is particularly efficient at butchering large carcasses (Galán & Domínguez-Rodrigo, 2014; Key & Lycett, 2017b; Toth & Schick, 2009). Indeed, from the outset of the Acheulean, at sites like Olduvai Gorge BK, hominins were regularly acquiring primary access to the carcasses of megafauna (Domínguez-Rodrigo et al., 2014; Domínguez-Rodrigo & Pickering, 2017).

As *Homo erectus* individuals did not have the physical strength or weaponry to bring down megafauna on their own, hunting these species would necessarily have been a cooperative endeavor. Butchered remains of large mammal carcasses in the Acheulean are often associated with multiple instances of the same tool type, handaxes, presumably wielded by multiple individuals (Goren-Inbar, Lister,

Werker, & Chech, 1994; Piperno & Tagliacozzo, 2001; Roberts & Parfitt, 1999). The transport of elephant heads, which weigh over 400 kg, to Acheulean sites suggests the cooperation of multiple individuals (Agam & Barkai, 2016).

Homo erectus was evidently a very successful species, occupying much of Africa and Eurasia below 55° latitude, but notably not Australasia. Some Acheulean sites dwarf those of the Oldowan in terms of number and density of artifacts (de la Torre, 2011; Domínguez-Rodrigo & Pickering, 2017; Foley & Lahr, 2015; Lahr et al., 2008; Potts, 1994; Rogers, Harris, & Feibel, 1994), indicating that perhaps they were made by larger groups.

Living in larger groups and the cooperative hunting of very large and dangerous animals would have presented an adaptive problem for *Homo erectus*: how to ensure that relatively unfamiliar group mates would be reliable cooperative partners in unpredictable and dangerous situations. The solution to this problem may have been selection for normative prosociality.

Normativity refers to the conventions and institutions that pervade human social life and exist beyond the confines of individual dyadic relationships (Claidière & Whiten, 2012). Norms are the collective agreement of the group about the way people *ought* to behave; and as such they provide a standard against which to judge behavioral variation. Norms include moral codes and social conventions, both of which can differ from group to group in a seemingly arbitrary fashion. Humans will conform to norms even when doing so incurs a significant cost (Henrich et al., 2006; Lyons, Damrosch, Lin, Macris, & Keil, 2011). One aspect of normative behavior that is perhaps universal is the prescription for prosocial behavior, such as helping, sharing with, and being fair to other group members (Tomasello & Vaish, 2013).

Normative behavior has several advantages for cooperation. Similarity in behavior creates affiliation between individuals (Lakin, Jefferis, Cheng, & Chartrand, 2003). A normative predisposition to empathize is a more efficient way of solving the problem of whether to commit to an unknown partner than conscious reasoning (Frank, 1988). The expectation of similar behavioral standards is critical to initiating cooperation in a delayed reciprocity relationship (Boyd, Gintis, Bowles, & Richerson, 2003). And normative standards enhance communication as more assumptions can be made about the intentions of others (Tomasello, 2008).

Normative behavior is unique to humans, and seems to have its ontogenetic origins in overimitation (Nielsen, Kapitány, & Elkins, 2015; Rossano, 2012). Here, seemingly redundant behaviors are copied faithfully if they are perceived as intentional, leading to a particular way of doing things: ontogenetically between a caregiver and infant, and sociogenetically between members of the same group. From around 3 years of age human children begin to speak in terms of generally applicable norms, a collective “we” mentality, as opposed to focusing on specific relationships or interactions (Wyman, Rakoczy, & Tomasello, 2009). The emotional weight of infant-caregiver interactions transfers to the normative way of doing something, so that infants will spontaneously defend norms (Rossano, 2012). At 3 years, human children will attempt to enforce norms at a personal cost even when they are third party observers to an interaction (Rakoczy, Brosche, Warneken, & Tomasello, 2009;

Tomasello & Vaish, 2013). Infants learn to please others by displaying normative culturally appropriate behaviors and thereby gain acceptance into the cultural group (Rossano, 2012).

Overimitation is first manifested in the production of some Acheulean stone tools (Nielsen, 2012; Shipton, *in press-a*; Shipton & Nielsen, 2015), and may have formed the evolutionary basis for the emergence of norms. Like overimitation, normative behavior is perhaps initially archaeologically evident in the Acheulean (Finkel & Barkai, 2018). Acheulean tools vary from assemblage to assemblage in subtle but consistent ways, such that each assemblage may be described as varying around an average type (Schick & Clark, 2003). During the later stages of the Acheulean, at the edge of the Acheulean occupied world in Britain, these types reach striking levels of specificity and finesse (Bridgland & White, 2014, 2015). Acheulean hominins repeatedly colonized and then abandoned Britain during warm and cold Marine Isotope Stages (MIS) and sub-stages, with distinct types of handaxes evident in each colonization phase (Figure 9.1). Experimental evidence shows that neither functional constraints (Key & Lycett, 2017a), nor the degree of knapping, nor the parts of the edge that were knapped are able to explain such differences (Shipton & Clarkson, 2015).

Overimitation by itself is not enough to explain the similarities in these forms, as the uniqueness of every clast of stone, particularly the relatively small, irregular-shaped, and internally variable nodules of flint from which the examples in Figure 9.1 were made, ensures that the same actions would not produce the same types. Furthermore, occasionally the same specific types are produced using very different methods, such as the plano-convex handaxes from Hitchin, which can be made on both cobble and flake blanks. What is also noteworthy is that there are often multiple different types within the same assemblages such as the cordate and ovate handaxes from Boxgrove, or the plano-convex and twisted handaxes from Hitchin (Figure 9.1). This suggests that mere conformity to the most common model is insufficient to explain the recurrence of some specific types. The tranchet resharpening on the Boxgrove handaxes suggests hominins were strongly motivated to produce these forms, as tranchet flaking is a highly risky strategy that can often result in breaking the handaxe in two. The specificity, deliberation, and risk involved in creating each of these types are such that they seem to have been maintained through a normative standard of what were acceptable forms for handaxes.

Acheulean hominins were acquiring larger carcasses and living in larger groups than their Oldowan predecessors. This success placed a new selective pressure on these hominins to further cooperation with group mates (including relatively unfamiliar ones) in unpredictable realms such as hunting large and dangerous animals. The result was an increased predisposition to normative behavioral standards, most clearly evident in the Acheulean of Britain ~500,000–300,000 years ago, where seemingly arbitrary but very specific handaxe forms characterize different occupation phases. Such norms were likely implicit default regularities in behavior at this stage (Railton, 2006), rather than the bases for the explicit and elaborate rituals that have formed part of our normative repertoire in the last 70,000 years (see the following text and Sterelny, this volume).

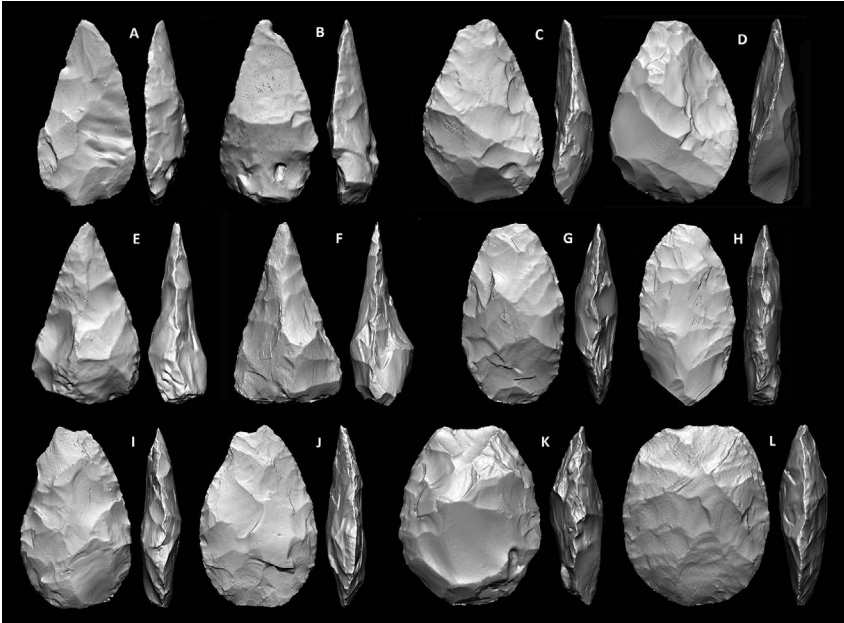


Figure 9.1 Plan and profile views of pairs of British Acheulean handaxes. The specimens are standardized for length in order to facilitate comparisons of shape. A and B = Planoconvex handaxes from Hitchin (MIS 11). Note that unlike the other types that are approximately symmetrical in profile, they have one domed and one flat surface. C and D = Twisted handaxes from Hitchin. Note that unlike the other handaxes that have approximately straight edges, these have a fine z-twist on the edge. E and F = Triangular handaxes from Swanscombe (MIS 11). Note that they are pointier and their points of maximum breadth and thickness are closer to the base than the other types. G and H = Limande handaxes from High Lodge (MIS13). Note that these handaxes are more elongate and have their point of maximum breadth more centrally positioned than the other types. I and J = Cordate handaxes from Boxgrove (MIS13). These handaxes are closest to the classic teardrop shape common throughout the Acheulean, but they have been finished with a single large oblique removal on the tip called a tranchet. Tranchet flaking is difficult to achieve without breaking the biface and is unusual in the Acheulean. K and L = Ovate handaxes from Boxgrove. Note that as well as being particularly rounded these two handaxes have also been finished using the tranchet technique that was common at Boxgrove.

Figure 9.1 is to be made available as a downloadable e-resource at www.routledge.com/9781138594500.

Source: Original figure by the author.

Recursion in the Middle Palaeolithic

Acheulean hominins had a relatively stable niche, which they exploited for hundreds of thousands of years. They were successful and ecologically dominant; and they were strong enough to make extremely large stone flakes (Sharon, 2007), extracting the most nutrient dense meat resources (Ben-Dor, Gopher, Hershkovitz, & Barkai,

2011), and occupying prime positions on the landscape near fresh water sources (Hardaker, 2011; Shipton, Blinkhorn, et al., 2018; Wendorf & Schild, 1980).

By the late Acheulean, within the last 500,000 years, hominin populations had increased significantly. For example, in Europe and the Levant, which have the most comprehensive Lower Palaeolithic records, the great majority of sites date from the last 500,000 years, even though the total length of occupation is over twice that age (Dennell, 2008; Gamble, 1999). Increasing regionalization of technology is evident with distinct industries such as the Acheulo-Yabrudian in the Levant (Gisis & Ronen, 2006) or the Fauresmith in southern Africa (Porat et al., 2010). This suggests that despite increasing population sizes, hominin traditions were becoming more divergent, a trend that continues into the Middle Palaeolithic (or Middle Stone Age as it is referred to in Africa) (Clark, 1988).

The success of *Homo* would inevitably lead to a point in our evolution when our main competitors were other hominins (Flinn, Geary, & Ward, 2005). Increasing competition among hominins in the late Acheulean, including between normatively divergent groups, may have led to selection for recursive thinking, allowing hominins to extract more out of existing environments and expand into new ones.

Recursion is the ability to embed discrete concepts within broader concepts, often with feedback loops (Coolidge, Overmann, & Wynn, 2011). It allows for the construction of elaborate hierarchical complexity in behavioral sequences, including the recombination of existing concept groups to create novelty. The human ability to think recursively is unparalleled in the animal kingdom and is integral to traits such as grammatical language and planning for the future (Corballis, 2014).

Recursion is perhaps most clearly evident in the quintessential technology of the Middle Palaeolithic: Levallois (Hoffecker, 2007; Shipton et al., 2013). Levallois takes concepts evident in various late Acheulean knapping sequences, in particular striking large, flat, elongate flake blanks, from hierarchically organized surfaces (a strategy known as debitage), then embeds these concepts into aspects of biface knapping, in particular shaping a bifacial surface and preparing platforms (a strategy known as faconnage), thereby creating a whole new mode of knapping (Hopkinson, 2007; Shipton, 2016; Shipton et al., 2013; White & Ashton, 2003). Across a number of measures, Levallois knapping has been shown to be significantly more hierarchically complex than even making the refined handaxes of the late Acheulean (Muller, Clarkson, & Shipton, 2017). Factoring in that Levallois stone tools were embedded in a wider sequence of creating a wooden haft and then attaching the two using a binding (Hoffecker, 2007; Sykes, 2015) (something not applicable to the handheld Acheulean stone tools), the difference in hierarchical complexity between Middle Palaeolithic Levallois and Acheulean handaxe technology is stark. Hafting is probably the key invention underpinning the Middle Palaeolithic, enhancing both the purchase that can be gained on stone tools and the variety of ways in which they can be used (Barham, 2013). Critically, hafting a stone tip onto a spear makes it significantly more lethal (Wilkins, Schoville, & Brown, 2014), enabling Middle Palaeolithic hominins to be more effective hunters than their Acheulean forebears.

The earliest instance of Levallois is from the late Acheulean of the Kapthurin Formation in Kenya (Tryon, McBrearty, & Texier, 2005), where the technology was used to make large handheld tools like cleavers. In this case the Levallois core was abandoned after striking the preferential cleaver flake. Levallois technology continues into the Middle Palaeolithic localities of the Kapthurin Formation, but this time the smaller cores are “recurrent” (Figure 9.2), with multiple preferential flakes

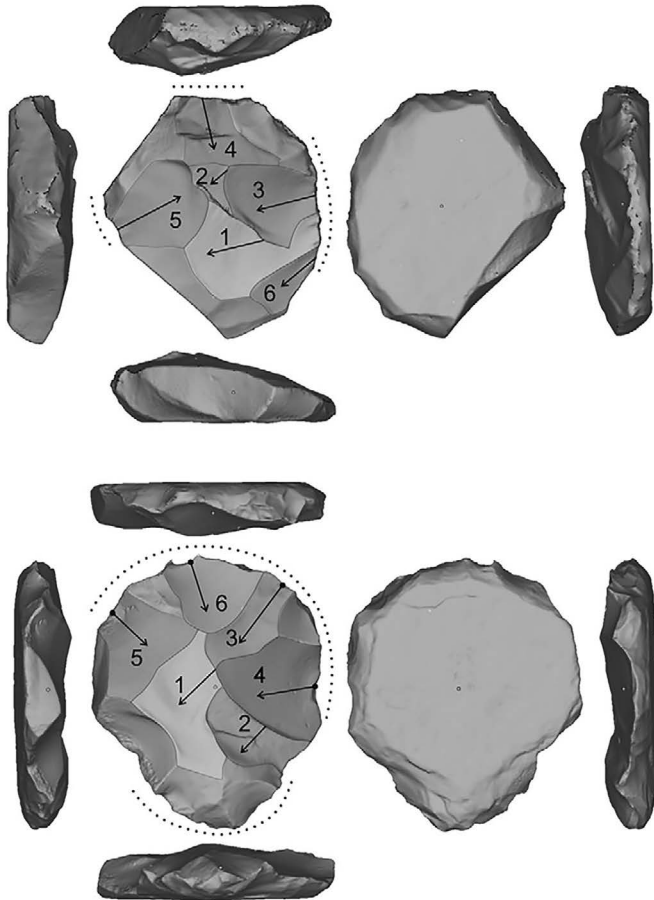


Figure 9.2 Recurrent Levallois cores from the Son Valley in India. Numbered scars denote preferential removals and their sequential order. Dotting denotes parts of the perimeter where the striking platform has been faceted to strengthen it. The upper specimen is from the Middle Palaeolithic site of Dhaba (Haslam et al., 2012), and the lower specimen is from the transitional Acheulean to Middle Palaeolithic site of Patpara (Shipton et al., 2013).

Figure 9.2 is to be made available as a downloadable e-resource at www.routledge.com/9781138594500.

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struck from the same core in a feedback loop of rePreparing the core after each preferential strike (Schlanger, 1996). Such feedback loops are recursive because they are a discrete process embedded within a broader knapping schema. Elsewhere in the Middle Palaeolithic it has been suggested that these recurrent cores were used to produce multiple different tool types in a single production sequence (Shimelmitz & Kuhn, 2013), indicating the embedding of multiple discrete concepts in an overarching scheme. Tantalizingly, there is the distinct possibility that the tool used to prepare a haft (e.g., a scraper for debarking and smoothing) would be embedded into the same knapping sequence as the tool to be attached to that haft (e.g., a Levallois point spearhead).

Recursion is perhaps the hallmark of Middle Palaeolithic knapping technology, but it may also be manifested in other aspects of behavior. Acheulean hominins seem to have used short-term landscape use strategies, with sites predominantly associated with easy to access knappable stone outcrops or nearby freshwater sources, and with short life histories of stone tools (e.g., Copeland & Hours, 1989; Goren-Inbar, 2011; Pappu & Deo, 1994; Shipton, Blinkhorn, et al., 2018; Shipton & Clarkson, 2015). In the Middle Palaeolithic, however, hominins were occupying upland regions (Giles Pacheco, Santiago Perez, Gutierrez Lopez, Mata Almonte, & Aguilera Rodriguez, 2000; Roustaei, 2010), and targeting high-quality and difficult to access stone (Groucutt et al., 2017), which was sometimes transported over distances requiring several days' travel (Blegen, 2017; Brooks et al., 2018; Féblot-Augustins, 1999; Merrick, Brown, & Nash, 1994; Nash et al., 2013). Concomitantly, Middle Palaeolithic stone tools have longer and more spatially fragmented life histories in comparison to those of the Acheulean (Shipton et al., 2013; Turq, Roebroeks, Bourguignon, & Faivre, 2013). This difference in landscape use may be underpinned by recursion, with stone procurement and tool production recursively embedded within spatially and temporally broader journeys. Such embedding is particularly indicated in the targeting of seasonal migrations of ungulate species and the transport of exotic stone to such locations (Costamagno, Liliane, Cédric, Bernard, & Bruno, 2006; Gaudzinski & Roebroeks, 2000).

By the end of the Acheulean hominin population size was increasing rapidly, perhaps leading to greater competition between both individuals and groups. The result was selection for more recursive thinking, whereby discrete concepts could be recombined and embedded within one another to create novel and more hierarchically complex sequences of behavior involving feedback loops. This enabled hominins to make more complex, more diverse, and more effective hafted stone tools, and to engage in behaviors requiring complex planning, such as climbing to uplands, occupying seasonally inhospitable regions, and targeting long-distance prey migrations.

Abstraction in the late Paleolithic

During the Middle Palaeolithic, particularly in the later part, there is evidence for behaviors that suggests hominin concern with abstract concepts such as their spiritual life. Early burials c.120,000–90,000 years ago at the Skhul and Qafzeh

caves in the Levant include examples in which the bodies wore shell beads and red pigment, and had votive offerings placed with them, such as a cow skull, boar jaw, and deer antlers (Garrod & Bate, 1937; Grün et al., 2005; Hovers et al., 2003; Mayer, Vandermeersch, & Bar-Yosef, 2009; Vandermeersch, 1970; Vanhaeren et al., 2006). However, such evidence is relatively sporadic, with ubiquitous and continuous evidence for these behaviors not apparent until the later Palaeolithic (d'Errico & Stringer, 2011).

The beginnings of the late Palaeolithic (or Later Stone Age as it is called in Africa) has recently been dated to around 67,000 years ago at the site of Panga ya Saidi in eastern Africa (Shipton, Roberts, et al., 2018). At the same time in southern Africa, the Howiesons Poort culture also features innovations in stone tool technology (Gibson, Wadley, & Williamson, 2004; Soriano, Villa, & Wadley, 2007). These innovative technologies occur at the beginning of MIS4, immediately after the MIS5–4 transition that marks the end of the last interglacial and the beginning of the most recent glacial period: a transition marked by rapid climate change across Africa (Blome, Cohen, Tryon, Brooks, & Russell, 2012; Revel et al., 2010; Schüller, Hemp, Zech, & Behling, 2012; Woltering, Johnson, Werne, Schouten, & Damsté, 2011; Ziegler et al., 2013). Rapid cooling and drying were possibly exacerbated by the Toba super-eruption c. 74,000 years ago, the largest volcanic event of the last two million years, but this is the subject of much debate (Ambrose, 1998; Lane, Chorn, & Johnson, 2013; Robock et al., 2009; Smith et al., 2018; Williams et al., 2009).

When we examine specific sequences such as Panga ya Saidi on the coast of eastern Africa, the earliest late Palaeolithic is preceded by a period of aridification (Shipton, Roberts, et al., 2018). During this time there is also a fall-off in human occupation signatures such as stone artifacts, charcoal, and the magnetic susceptibility of sediments, suggesting local population stress. Likewise, the Howiesons Poort in southern Africa is preceded by environmental perturbation and relatively low population density (Jacobs & Roberts, 2009). Environmental fluctuations in eastern and southern Africa around 70,000 years ago may have led to selection for a latent abstraction capacity in *Homo sapiens*: This allowed populations both to expand their social networks in order to buffer against local resource shortages, and to create novel technologies for both the maintenance of those networks and increased hunting efficiency.

Abstraction is the ability to think about intangible concepts. It builds on the recursive ability to embed discrete concepts within others and combines this with the possibility of multiple states (including fantastical ones) for individual concepts. Examples of abstraction include an afterlife where one might have use for grave goods (Wynn, 2008); the notion of higher level social groupings other than individuals in physical proximity (an individual can have two states in the same category, so they can be a member of both a proximal group and a broader tribe) (Ambrose, 2010); or the mental combination of two entirely separate tool concepts to create an interdependent set of multiple-state artifacts, as in the bow and arrow, dart-and spear-thrower, or line and hook (Coolidge, Haidle, Lombard, & Wynn, 2016). A further component of abstraction is ordinal thinking, where recurrences of like

concepts change their significance with each addition, such as days of the week, thereby functioning as multiple-state entities (Coolidge & Overmann, 2012).

The late Palaeolithic provides evidence for the adaptive use of abstraction in a number of realms. In what has been termed “the troop to tribe transition” (Ambrose, 2002; Ambrose & Schapiro, 2014), it has been argued that one of the distinguishing features of the late Palaeolithic from earlier periods is the emergence of higher level social groupings. The late Palaeolithic is characterized by increased use of exotic stone materials, perhaps representing long-distance exchange networks (Ambrose, 2002, 2012). There is also the habitual use and exchange of beads (Balme & Morse, 2006; d’Errico et al., 2012; Kuhn, Stiner, Reese, & Güleş, 2001; Miller, 2012; P. J. Mitchell, 1996; Vanhaeren, d’Errico, Billy, & Grousset, 2004), which in traditional societies are used to denote tribal identity and mediate intergroup cooperation – in particular creating marriage alliances and facilitating access to remote resources (Hitchcock, 2012; Vanhaeren & d’Errico, 2006). Building on our normative proclivities, ways of doing fantastical things could have been ontogenetically translated (Nielsen, this volume; Kapitány & Nielsen, 2015; Nielsen, 2018; Nielsen, Kapitány, & Elkins, 2015; Rossano, 2012) into elaborate late Palaeolithic group rituals (e.g., Einwögerer et al., 2006; Lewis-Williams, 1994), with such rituals being effective ways of both ensuring tribal membership and cementing tribal bonds (Sterelny, 2014).

A novel artifact found in the late Palaeolithic is notched bones with no obvious utilitarian wear (Figure 9.3). Only one such artifact has been found older than 70,000 years ago, and this is a doubtful piece (d’Errico, Backwell, & Wadley, 2012). These notched bones occur with sufficient regularity in the late Palaeolithic, where preservation conditions are adequate (e.g., d’Errico et al., 2012; Langley et al., 2016; Wendt, 1976), to suggest that they represent a new type of behavior. Sometimes the marks are made with different tools at different times, and one common interpretation is that they were notational objects, making use of ordinal cognition to record and convey information extra-somatically (d’Errico, 1995; d’Errico & Cacho, 1994; d’Errico, 1998; Dewez, 1974; Pletser & Huylebrouck, 1999). A complementary purpose might have been as authoritative communication devices between disparate groups, in the manner of ethnographically documented notched message sticks in Australia (Howitt, 1889).

A further distinctive feature of the late Palaeolithic in Africa is the habitual creation of miniaturized stone tools (Pargeter, 2016; Shipton, Roberts, et al., 2018). From ~67,000 years ago in eastern Africa and from ~44,000 years ago in southern Africa, knappers were deliberately creating small stone flakes on the most fine-grained, and therefore sharpest, materials available (Shipton, Roberts, et al., 2018; Villa et al., 2012). This shift in size and material of stone tools implies a new way of using them, perhaps cumulatively combining multiple small sharp and disposable cutting tools for individual tasks (such as carving a bone). In ethnographically documented examples from Australia, small sharp stone flakes were combined through serial hafting on the same tool to create saws and barbed weapons called death-spears (Davidson, 1934; S. R. Mitchell, 1959). Finding such compound artifacts preserved in the archaeological record is a long-shot, but backed crescents, a distinctive artifact

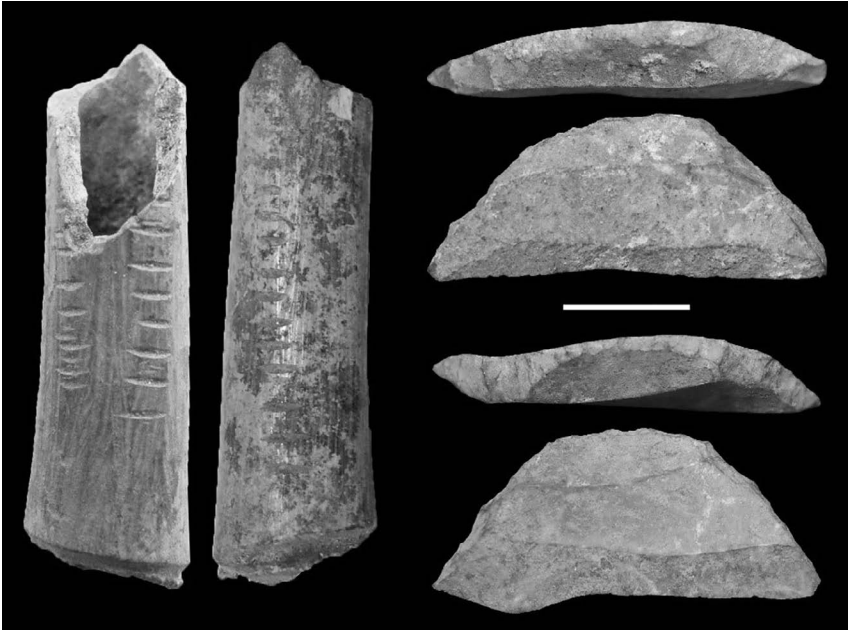


Figure 9.3 A notched bone (left) and two backed crescents from the site of Panga ya Saidi in Kenya. The scale bar is 1 cm long. The notched bone is from a layer (8) dating to around 25,000 years ago, and the crescents are from layers (11 and 12) dating to around 48,500 years ago (Shipton, Roberts, et al., 2018).

Figure 9.3 is to be made available as a downloadable e-resource at www.routledge.com/9781138594500.

Source: Original figure by the author.

type that recurs in miniaturized assemblages all over the world, offer an insight (Figure 9.3) (Clarkson, Hiscock, Mackay, & Shipton, 2018). These tools have very regular crescentic shapes and were blunted on one edge to improve mastic adhesion in hafting. Ethnographic examples and rare conditions of exceptional archaeological preservation indicate that such crescents were sometimes hafted in series to create barbed compound tools (Fullagar, McDonald, Field, & Donlon, 2009; Larsson & Sjöström, 2011; McCarthy, 1967; Yaroshevich, Nadel, & Tsatskin, 2013). One of the key advantages of backed crescents is that they could break, fall out or become blunt and be easily replaced due to their standardized shape (Clarkson et al., 2018). Backed crescents in particular, therefore, and perhaps miniaturized tools in general, seem to represent tools that had an abstract existence, independent of their component parts.

As well as being hafted as barbs, a common way in which backed crescents were used ethnographically was to have two glued back to back on the end of a thin shaft to create a pointed arrowhead (Clark, 1975). The earliest backed crescents in the world are from the Howiesons Poort industry of southern Africa, with

microscopic functional studies indicating some were used as arrow tips (Lombard, 2011; Lombard & Phillipson, 2010). To envision a bow and arrow set requires the combination of two separate yet interdependent tool concepts to create a multiple-state artifact (Hoffecker & Hoffecker, 2018; Lombard & Haidle, 2012). These backed crescents were glued to the arrow shafts using compound adhesives whereby several different materials were combined and transformed so that the finished product was qualitatively different from each of its constituents (Wadley, Hodgskiss, & Grant, 2009). The ability to conceive of such mutually compatible transformations again requires the mental transformation of separate yet interdependent concepts (Wadley, 2010a).

Around 70,000 years ago, rapid climatic fluctuations placed stresses on some hominin populations. In both eastern and southern Africa, the response to this was selection for a latent capacity for abstraction in *Homo sapiens*. Abstraction allowed humans to conceive of a tribal supergroup at a level of organization above that of the immediate social group, and thereby allowed access to distant resources. It allowed for the recording and transmission of information extra-somatically, including perhaps intergroup messages. It allowed for new serially hafted compound tools that could be easily repaired and rejuvenated, the manufacture of compound adhesives, and the creation of the pinnacle of Palaeolithic hunting technology: the bow and arrow.

Conclusion

This chapter has presented a three-stage model for the evolution of human cognition over the last million years. In adopting an explicitly gradualist position, it eschews explanations of a sudden appearance of distinctively human behavior resulting from some all-important singularity. Instead, it attempts to understand the selective context for the various faculties that distinguish our cognition from that of our closest cousin species. To reiterate, though the selective context and the cognitive faculty are presented in the preceding text as linked hypotheses for each period, they are not interdependent. There may be other adaptive explanations that better explain the appearance of the cognitive faculty (including those in this volume), or there may be other faculties that emerged as a result of those selective pressures.

In the model presented here, our ancestors were habitual overimitators before one million years ago, due to their need to reliably transmit technology. Using overimitation as an ontogenetic basis for group norms of behavior, our ancestors became obligate cooperators in order to more effectively hunt large and dangerous prey within large social groups. The cooperative hunting niche proved so successful for our genus that eventually competition with other hominins, both within and between groups, was the strongest selective pressure operating on our ancestors. This led them to use recursive thinking to expand their use of the landscape and to more effectively extract resources using hafted stone tools. Middle Palaeolithic hominins seem to have sporadically expressed the ability to think abstractly;

however, this ability is not consistently manifested until the late Palaeolithic after 70,000 years ago. Environmental perturbations in eastern and southern Africa at that time may have placed a selective pressure on abstraction. Building on existing capacities for normativity and recursion, abstraction allowed hominins to form supergroups in which they could access resources from distant territories in times of need, as well as to create multiple-state hunter-gatherer technologies. The capacity to create multiple-state technologies, such as traps (Wadley, 2010b), and fish hooks (O'Connor, Ono, & Clarkson, 2011), may have been a driving force behind the dispersal of our species from which all non-Africans are descended, and which for the first time saw hominins colonizing Australasia, Siberia, and the Americas (Hoffecker & Hoffecker, 2017).

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10

THE EVOLUTION OF LEARNING AND MEMORY IN HUMANS

Comparative perspectives on testing adaptive hypotheses

Mark A. Krause and Crickette Sanz

Learning and memory are key mechanisms of behavioral plasticity, and while their machinery is relatively well understood, we should also seek to better understand their ultimate, adaptive significance. However, the learning and memory processes of our distant ancestors have not left us much in the way of physical artifacts that help us better understand historically adaptive challenges. It is quite plausible that learning and memory were adaptive processes affording behavioral plasticity and adaptiveness, which would likely be essential to migration over great distances, exploiting resources in changing environments, and functioning in complex social groups. These speculations justify our integrating the science of learning and memory with the field of cognitive archaeology. In this chapter on the evolution of learning and memory in humans, we highlight what is known about learning and memory in an attempt to replace speculation with data. We will also consider some limitations to understanding the evolution of human learning and memory. Methodologies currently used in psychological and biological sciences will be key in addressing some of these limitations.

So, what is the biological function of being able to learn and remember? This very general question likely yields correspondingly general answers such as (1) it allows organisms to adjust to environmental changes (provides flexibility), (2) it prepares organisms to use previous experiences to prepare for future challenges, (3) it enhances survival such that immediate responses to environmental contingencies are adaptive (survival promoting and energy conserving), and (4) in some circumstances, it enables organisms to take advantage of the accumulated knowledge of conspecifics. Although

each answer is plausible, if not completely true, not one of them tells us much of anything about the evolution of human learning and memory, or, for that matter, any other species. Each of the different processes of learning and memory described in Table 10.1 can satisfy the previously mentioned functions to at least some extent.

Each of the learning and memory processes described in Table 10.1 is expressed, to varying degrees, by nonhuman species. Habituation and sensitization are nearly ubiquitous among organisms with even the most basic nervous systems, and associative learning is nearly so (Ginsburg & Jablonka, 2010). Operant (reward-punishment) based learning is similarly found across a wide diversity of species, and probably the majority of research in this area involves studies of laboratory animals such as pigeons

Table 10.1 Different primary processes of learning and memory and their descriptions

<i>Learning/memory process</i>	<i>Description</i>	<i>Example</i>
Habituation/sensitization	Increased or decreased response to repeated stimulation	Reduced or enhanced gill withdrawal reflex in sea slugs following repeated stimulation
Associative learning	A change in responding due to the co-occurrence of two or more stimuli	Acquisition of appetitive response toward cues previously paired with sweet (sucrose) solution in rats
Operant conditioning	A change in behavior due to rewarding or punishing consequences	Pigeon pecking a key in order to obtain grain, or avoidance of a location in which a predator had been previously encountered
Social/observational learning	Acquisition of specific behavioral pattern or making a choice following the opportunity to perceive another engaging in the behavior	Seeking out specific food sources that were present on the breath of conspecifics
Declarative memory	Memory for individual, personal events and their spatial and temporal arrangement; includes memory for factual (semantic) information	Remembering the location, type of food source, and time in which caching took place
Spatial memory	Memory for physical environment and one's orientation within that environment	Learning and remembering the pathway required to return to a burrow or nest
Working memory	A set of cognitive processes that are involved in the temporary holding and manipulation of information	Rats keeping track of whether a reward was available in each of eight arms in a radial maze

and rats. Spatial memory, which encompasses memory for physical surroundings, is also phylogenetically widespread. Many animals learn by observing conspecifics, though there are very different levels of complexity in terms of processes that support learning from others (e.g., stimulus enhancement, a lower level process, compared with cultural learning, which may involve complex processes such as imitation and teaching). Some aspects of declarative and working memory are found in a wide diversity of nonhuman species. So although it is interesting to think about macro level questions about how learning and memory evolved, a more fine-tuned approach is needed if we want to understand the evolution of learning and memory capacities of a specific taxonomic group, such as *Homo*. In other words, do humans uniquely employ learning and memory processes shared with nonhuman species?

Contrasting perspectives: general processes or adaptive specializations

At first blush, the contents of Table 10.1 might reinforce the perspective that these processes represent general mechanisms of learning and memory. The definitions offer basic accounts of how each process works, possibly making them seem arbitrary with respect to the species involved or the specific ecological circumstances in which learning occurs. Also, while individuals will vary in their capacities to express different processes of learning and memory, each respective one basically works the same way. For example, a general process description of Pavlovian conditioning, a form of associative learning, would predict that stimuli and responses are equal in their potential to be paired in a manner that results in conditioned responding. This “principle of equipotentiality” has a long history in the animal learning literature (Domjan, Cusato, & Krause, 2004). It does so in part because researchers of animal learning have traditionally focused on a limited number of laboratory bred species (rats or pigeons) and have used a limited number of stimuli (tones or lights) to condition a specific type of response (fear or food/drink appetitive behavior). It should be noted that the principle of equipotentiality, and the narrow scope it encourages, has in fact provided the bases for a rich experimental and theoretical tradition in the field of animal learning.

However, functional approaches to animal learning have shown that not all general processes account for the diverse ways that organisms learn via Pavlovian conditioning, for example (Domjan, 2005). In fact, laboratory studies that integrate ecologically valid stimuli into their designs show that conditioning does not necessarily happen in ways that general process theories predict. For example, signature effects of conditioning such as extinction, blocking, and latent inhibition do not occur as traditionally predicted, if at all, when a conditioned stimulus (CS) that includes species-typical visual cues is used. This has been shown in work using male Japanese quail (*Coturnix japonica*) as subjects. Males that are exposed to a CS that includes limited visual cues of a female quail (e.g., head and neck feathers) condition differently in comparison to males exposed to a CS that lacks these cues but is otherwise identical. The conditioned approach and copulatory behaviors that male quail direct toward the naturalistic CS are not nearly as susceptible to the response attenuating effects of extinction, blocking,

and latent inhibition (reviewed in Domjan & Krause, 2017). These are among several key findings in the area of animal learning that have shifted some of the field's focus on proximate, general process mechanisms to ultimate, fitness-relevant ones.

Parallel scientific debate and inquiry characterizes the study of human learning and memory. For much of its rich history in experimental psychology, and now with its interdisciplinary reach into neuroscience, the study of learning and memory has similarly focused on underlying general, proximate mechanisms. For example, episodic memory encompasses individual events that are encoded and stored along with temporal and spatial details. With the exception of amnesiacs, all humans possess episodic memory, and all can benefit in terms of increased memory span by using strategies such as elaborative rehearsal. As with the animal literature, many investigators have begun considering the evolutionary, functional significance of human memory (Klein, Cosmides, Tooby, & Chance, 2002; Sherry & Schacter, 1987), and some have designed experiments to test evolutionary hypotheses (Nairne, Thompson, & Pandeirada, 2007).

The integration of evolutionary perspectives into animal and human learning and memory is fortuitous, because an evolutionary account of learning and memory in humans needs to consider the phylogenetic origins of these processes, and an interest and will to conduct experiments that test evolutionary hypotheses. It is fortuitous not only for psychological science, but for the field of cognitive archaeology. Psychological perspectives on learning and memory would be of little use to cognitive archaeology if no progress had been made in addressing evolutionary questions.

The survival processing effect

For over a decade, memory researchers have explored the depths of what is termed the survival processing effect (SPE). Originally described by Nairne et al. (2007), the methodology involves testing whether words encoded in relation to survival in an evolutionarily relevant scenario are better remembered than are words encoded in relation to non-evolutionary scenarios. The word “spatula” may seem mundane and forgettable, but if asked to decide whether spatulas are relevant to survival they suddenly become more memorable, especially if one can think of an actual survival-relevant use for one. In more technical terms, there is a mnemonic advantage to processing words in relation to their survival value. This effect may be particularly strong if one imagines whether the spatula would be of any use in an environment similar to those inhabited by our hominin ancestors. In Nairne et al.'s method participants first read a scenario in which they imagined a grassland environment thought to resemble ancestral habitat conditions wherein they had to secure resources and avoid predators. A comparison group was asked to imagine that they were moving to a new country, and that they must prepare for what this also uncertain situation would entail. Participants from both groups then rated items on an identical word list for their relevance to the corresponding scenario. After a distracter task (e.g., short-term memory for number span) a surprise memory test for the previously rated words was presented to the participants. Words rated in relation to the survival scenario were

better remembered than were words in the moving scenario, as well as in comparison to a control condition that required participants to simply rate whether the same words were pleasant or unpleasant (Figure 10.1; Nairne et al., 2007). These results have been replicated numerous times and have generated much interest and further experimentation (Schwartz, Howe, Toglia, & Otgaar, 2014).

The SPE and much of its relevant literature captures core principles of traditional evolutionary psychology. It can be summarized, if simplified, by a few major premises (see Heyes, 2012). First, the human brain, much like other physical structures, has been shaped by natural selection. This premise might seem trivial and

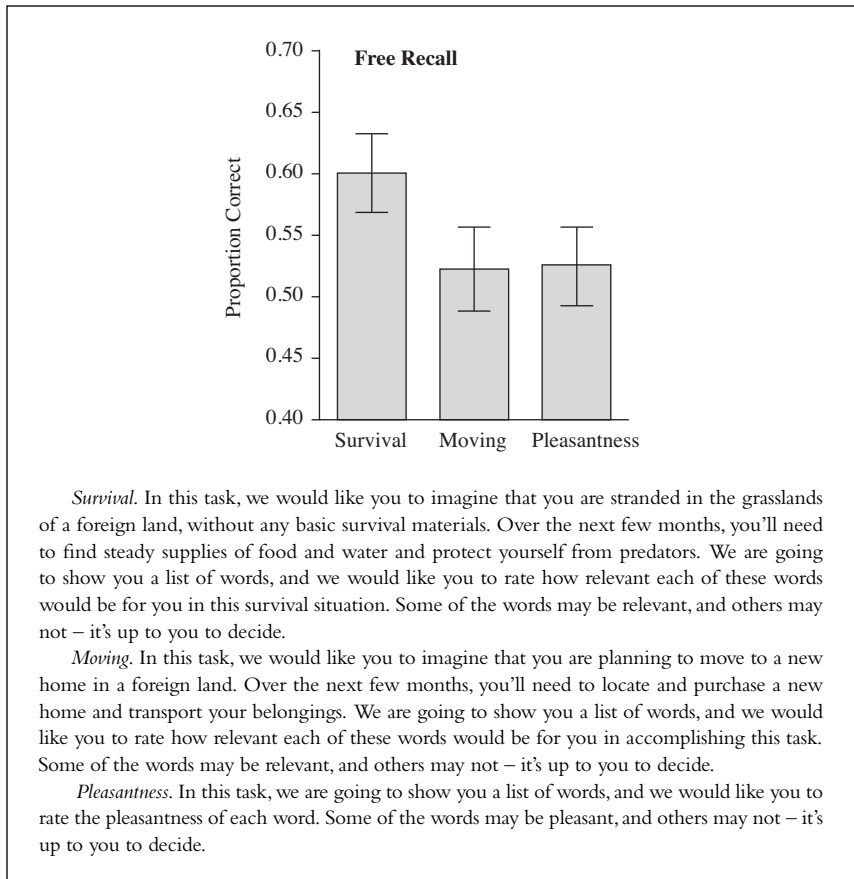


Figure 10.1 Participants better remember words rated for their relevance to survival in an evolutionarily relevant scenario compared with a scenario in which they prepare to move to a foreign country, or for words rated for their pleasantness.

Source: The chart portion of Figure 1 is reprinted from *Journal of Experimental Psychology: Learning, Memory, and Cognition*, March 1, 2007. Nairne, James, S., Thompson, Sarah, R., Pandierada Josefa, N. S. Adaptive memory: survival processing enhances retention. With permission from the American Psychological Association.

obvious. However, if we take Tooby and Cosmides (1992) at their words, many social scientists have historically been neither prepared for nor friendly toward such an audacious claim. Second, the result of natural selection on the human brain is a metaphorical Swiss Army knife consisting of specialized adaptive modules for solving specific problems that we, third, encountered in the environment of evolutionary adaptiveness during the Pleistocene epoch. Consistent with this approach to evolutionary psychology, Nairne and Pandeirada (2008) referred to the SPE as “remembering with a stone age brain.”

Competing explanations of the survival processing effect

On its surface the SPE does not compel us to dig very far back into our evolutionary history to uncover its origins. The task requires the ability to process verbal and written episodic information. It also presumes that natural selection has influenced how we process this kind of information. While this may indeed be the case, there are proximate explanations for the SPE that do not require a hypothetical brain module favored by natural selection because it enhanced our abilities to survive (Erdfelder & Kroneisen, 2014; Krause, 2015a). For example, Kroneisen and Erdfelder (2011) tested whether the distinctiveness of the survival scenario differentially influences the richness in which the to-be-remembered words are encoded. Thinking about whether a spatula would be of use in an evolutionary survival scenario, as opposed to during a move to another country, may simply be encoded more deeply because of the relative distinctiveness of the survival scenario. To test this hypothesis, researchers altered the original survival scenario used by Nairne et al. (2007) such that the only requirement was to find potable water (finding food and avoiding predators were omitted). If the SPE reflects the presence of a specialized, evolved memory module, then reducing the scenario should not reduce memory for the words encoded because survival in an ancestral habitat is still the essence of the scenario. However, fewer words were in fact remembered in the reduced scenario, and this led Kroneisen and Erdfelder (2011) to propose that richness of encoding, and not a memory module fine-tuned by natural selection, accounts for the SPE.

There are numerous other proximate mechanisms hypothesized to account for the SPE, some of which are strongly supported by data and others less so (reviewed in Erdfelder & Kroneisen; 2014; Krause, 2015a; Nairne & Pandeirada, 2016). The matter of whether humans evolved a specialized memory module for survival of relevant information is by no means settled by the richness of the encoding experiment described previously, or many others that have followed since Nairne et al. (2007). Soderstrom and McCabe (2011) found that even imagining having to survive a fictitious scenario (warding off zombies) generates superior word recall. Survival processing, regardless of the context toward which it is applied, does seem to confer mnemonic advantage (Kostic, McFarlan, & Cleary, 2012; Soderstrom & Cleary, 2014). Nairne and Pandeirada (2016) provide a rigorous defense of this point. However, finding an actual underlying, hypothesized memory module might be like finding a needle in a haystack, and with the probability that a needle was actually dropped in the first place being rather uncertain.

A potentially fruitful approach would be to link the work done on the SPE with other evolutionarily oriented work on episodic memory. One set of findings on the SPE published by Klein and colleagues (reviewed in Klein, 2014) leads us in this direction. For example, Klein, Robertson, and Delton (2011) report that planning for future situations, such as for a dinner party, results in comparable memory performance to the ancestral grassland survival scenario. It may be that the future-directed property of episodic memory, with known neural machinery powering it, was the material upon which natural selection has acted. We can then explore whether episodic memory is uniquely evolved in *Homo sapiens*.

The evolution of episodic memory

Two key developments took place on the way to modern *Homo sapiens*. We evolved a full-blown symbolic language with which to communicate and an ability to imagine ourselves in the future. Putting the two together, we find ourselves able to communicate about the abstractions of what has not yet happened, or what could possibly happen, and to use this information to guide how we behave in the present. Our kitchens are full of gadgets we acquired in anticipation of future needs. We are advised to avoid grocery shopping while hungry; the motivational state of the moment might confound our abilities to dissociate current need from what and how much we will actually want to eat in the upcoming days. The same is not said for buying kitchen supplies. The latter are more likely to be purchased without immediate hunger pangs driving our decisions, and with a mental mindset toward the future.

Long before *Homo sapiens* began overstocking their kitchens with implements for every occasion, our ancestors created and used tools to be used for future hunts. Oftentimes, early humans did not likely wait until they felt hungry or they happened upon a food source to start manufacturing these tools. Rather, they were made in *anticipation* of a future need. Without the capacity to anticipate both future hunger and food resource availability, their food would have been long gone, or they themselves might have become the food. This scenario is the basis for the Bischof-Köhler (1985) hypothesis, which states that humans alone anticipate future needs independent of current motivational or homeostatic states, and act to meet anticipated needs. Endel Tulving (2005), who receives much due credit for conceptualizing the unique components of episodic memory, argued that the linguistic and cognitive abilities required to power episodic memory are not found among nonhuman species. Debate over whether this is actually a unique human quality is ongoing, and resolving it is important to cognitive archaeology. Properly accounting for the adaptive significance of such mental time travel requires that we understand its origins.

Mental time travel is a flexible component of episodic memory, which comprises memories for personal events. But memories for whether we bought milk or deposited a large check are useful not as fodder for our biographies, but as information that is consequential to the future. We avoid eating dry cereal and bouncing checks because of our capacities to anticipate, and keep track of, future scenarios. Even more importantly, humans do things like build new hospitals because people will indefinitely

require their services. It is not such a great leap of faith to suppose that, under the right circumstances and with the right raw materials, natural selection could shape such a complex cognitive adaptation for handling probable or certain future events. It is reasonable to hypothesize that a population of organisms that acts upon its future needs before they actually arise would fare better than one stuck in the present. It is then also not such a stretch to suppose that episodic memory, as any other memory system, evolved through natural selection. But how and when did it evolve?

The cognitive neuroscience of memory provides some answers. First of all, based on Figure 10.2 it might appear that episodic and semantic memory systems are just different ways of handling consciously accessible experiences. However, the differences between the two are not trivial. Some amnesiacs are unable to encode any new episodic memories to speak of, but under some conditions can acquire new semantic memories (Hayman, Macdonald, & Tulving, 1993). Conversely, others may have selective amnesia for semantic, but not episodic, memories (Giovagnoli, Villani, Bell, Erbetta, & Avanzini, 2009). These cases show that the two systems are neurologically dissociable (though it should be noted that each serves the other – for example, our birth date is semantic information, with episodic memories of events that occur when we celebrate it). But what about the bidirectional nature of episodic memory, which is what allows us to mentally travel back and forth in time? Imagining, encoding, updating, and remembering memories for future events require the ability to access previously stored episodic memories from which to work. In fact, one could

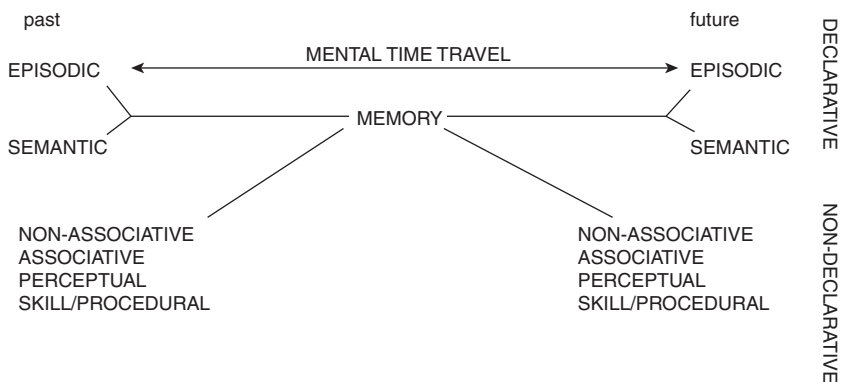


Figure 10.2 Long-term memory systems as conventionally organized in relation to whether they are consciously (declarative) or unconsciously (non-declarative) acquired.* The capacity to retrieve and replay past personal events and imagine oneself in future scenarios is thought to be a distinguishing characteristic of episodic memory.

Source: Diagram based on Squire (1992) and Suddendorf and Corballis (2007).

* The declarative/non-declarative dichotomy reinforces a distinction that is not at all clear. The issue of conscious awareness, and its role in so-called non-declarative memories, is far from resolved. That said, the conventional taxonomy of memory as presented here provides a useful guide for thinking about distinctions among multiple memory systems.

argue that from a functional perspective, episodic memories for past events are there in the service of handling present and future scenarios.

Functional neuroimaging data are consistent with this hypothesis. A primary function of the hippocampus is to support the encoding, consolidation, and retrieval of episodic memories. Regions of the hippocampus are activated when people remember both past and future-oriented memories, showing a common neural substrate for both (Figure 10.3; Addis, Wong, & Schacter, 2007). However, neural dissociation also occurs within the hippocampus and cortex. For example, subregions of the hippocampus are specialized with respect to temporal perspective, with the posterior regions of the hippocampus playing a role in storage and retrieval of past events, while the anterior hippocampus is involved in imagining future events (Martin, Schacter, Corballis, & Addis, 2011). Furthermore, episodic memory processes are multifaceted: We both construct and elaborate upon episodic memories. While the left hippocampus is involved in construction of both past and future events, the right hippocampus, right frontopolar cortex, and left ventrolateral prefrontal cortex are uniquely involved in future thinking (Addis et al., 2007).

Tracking the development of episodic memory reveals its complexity. Infants as young as 3 months are able to form what we *might* call declarative memories. For example, two tasks in particular have been developed to test the presence of episodic memory and changes in retention intervals through the first 18 months. In the mobile conjugate reinforcement method 2- to 7-month-old infants learn that they can cause a mobile to move by kicking, a response that infants of this age readily engage in (a ribbon connects their ankle to the mobile; reviewed in Rovee-Collier, 1999). The response is context specific and demonstrates renewal, meaning that extinguishing the response in one context (e.g., the crib in which acquisition and extinction trials took place) does not transfer to a novel context. In the operant train task, which was designed for use with older infants and toddlers (6–24 months),

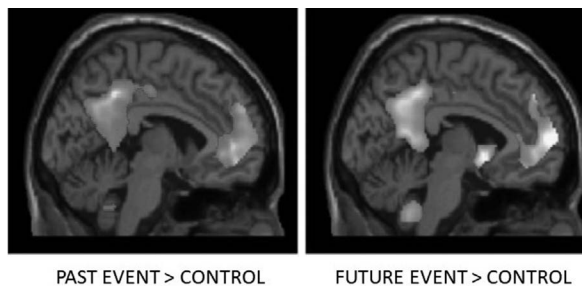


Figure 10.3 Parallel activation of medial left prefrontal and parietal regions during elaboration of past and future events.

Figure 10.3 is to be made available as a downloadable e-resource at www.routledge.com/9781138594500.

Source: From Addis, D.R., Wong, A.T., & Schacter, D.L. (2007). Remembering the past and imagining the future: Common and distinct neural substrates during event construction and elaboration. *Neuropsychologia*, 45, 1363–1377. With permission from Elsevier.

the child learns that a lever or button, when activated, will move an electric train (Hartshorn & Rovee-Collier, 1997). This work suggests that episodic memory processes are already developing during infancy, though historically there has been much debate as to whether they constitute declarative memory (Schacter & Moscovitch, 1984; Mullally & Maguire, 2014).

Testing episodic memory becomes more straightforward with children who are old enough to speak and have sufficient motor maturation that allows for a greater range of behavioral responses. Hayne and Imuta (2011) developed a “what-where-when” paradigm to study the development of episodic memory in 3- and 4-year-olds. An adult and child together hid toys in three different locations, and following a retention interval the child was asked to identify each toy hidden (what), each one’s location (where), and when each one was hidden. When asked to give a verbal account of what, when, and where, the older children surpassed the younger ones in their ability to correctly report the information. However, both 3- and 4-year-olds were similarly successful at a behaviorally based recall test in terms of correctly identifying where each toy was located (with 3-year-olds less successful at correctly identifying when each toy was hidden). These results indicate that between 3 and 4 years of age episodic memory transitions toward a more adult-like state, and it is noteworthy that this is also the timeframe in which childhood amnesia typically starts to recede. An important finding from developmental studies is that episodic memory processes are present in prelinguistic humans. Thus, the capacity to productively use language, at least, may not be a requisite capacity for episodic memory or mental time travel.

Comparative perspectives: continuity or hopeful monster?

Did survival processing, episodic memory, and mental time travel evolve *de novo* over a relatively brief evolutionary period leading to *Homo sapiens*? Geneticist Richard Goldschmidt (1940) refers to products of macroevolutionary changes occurring in short bursts of time as hopeful monsters, which in more technical terms refers to organisms that rapidly adapted via mutation on genes that regulate developmental processes. It is easy enough to ridicule the term “hopeful monster,” but the notion that evolution can accelerate and bring about novel adaptations in a relatively short amount of time should not make anyone too uncomfortable (assuming they endorse evolution). Further, there are several examples of recent and rapid evolution in anatomically modern humans. Livingstone’s (1958) landmark study on the distribution of sickle cell genes in Africa indicated genetic changes in human populations were attributable to horticulture and its influence on mosquito and malaria parasite ecology. Studying dairy farmers in Europe and Africa, scientists found evidence of convergence in the selection of different mutations associated with lactase persistence that has occurred in just the past 7,000 years (Tishkoff et al., 2007). Based on evolutionary theory, we should expect to detect more examples in the future as the potential for natural selection in our species increases with population growth (Hawks, Wang Cochran Harpending & Moyzis, 2007).

However, parsimony would suggest that, rather than a hopeful monster, the evolution of human episodic memory has played out in a plodding tempo of phyletic gradualism that began long before humans and their ancestors diverged from their common ancestor with chimpanzees and bonobos. Though it certainly remains possible that natural selection has uniquely influenced the evolution of episodic memory in humans, much as it has other adaptive traits, such a conclusion would be premature if evidence for the core features of episodic memory are present in nonhumans.

Episodic memory in nonhumans

The chimpanzee Tatu enjoys a good party, and she seems to know when guests are coming. She is among the five chimpanzees that Allen and Beatrix Gardner taught to use the signs of American Sign Language during the 1960s and 1970s. Following her years with the Gardners at the University of Nevada at Reno, Tatu was relocated to Central Washington University at the former Chimpanzee and Human Communication Institute. It was here that we both got to know Tatu, and each Halloween, Thanksgiving, and Christmas she and her fellow chimpanzee companions were treated to a raucous celebration. Tatu's enthusiasm for these celebrations was most evident. For each of the five years that we both spent working in this laboratory, the morning after Halloween, Tatu would respond to the question "what do you want to eat today?" by signing "bird meat." She did this regularly and without explicit prompting by humans (and, as far as we could tell, other chimps). The five enculturated chimpanzees were given "bird meat" on Thanksgiving, as they always had. Invariably, the morning after the Thanksgiving party, Tatu started asking for "candy tree" (a Christmas tree with sweet cereal garlands was always put up a few weeks afterward). "Candy tree" was repeated daily by Tatu until it finally arrived. These observations have stayed with us through the roughly 20 years that comparative psychologists have tested and debated the presence of episodic memory and mental time travel capacities in animals.

The laboratory staff all marveled at Tatu's behavior, which elegantly implicates several primary processes of learning and memory, but the evidence was anecdotal. Fortunately, some highly creative and rigorous experimental studies have been conducted to test for episodic memory (or the less committal "episodic-like" memory as some authors and critics alike prefer). Tatu notwithstanding, linguistic responses are not options for behavioral measures of episodic memory in animals, so we instead draw from carefully designed experiments using species that would plausibly need episodic memory for their survival. For example, scrub jays cache food supplies across their home range. The effectiveness of food caching could be maximized with well-developed memory abilities, including where food was cached, what the items were, and when the caching events took place. Clayton and Dickinson (1998) tested whether scrub jays are able to remember this type of information by simulating a naturalistic foraging situation. Birds were allowed to cache a food item that perishes slowly (peanuts) and one that perishes much more rapidly (wax moth larvae) in different locations. One group of birds (Degrade) learned across four trials that larvae decay over time, while a second group (Replenish) was not given a chance to learn this because their larvae were replaced before they could perish (Figure 10.4). Using only the

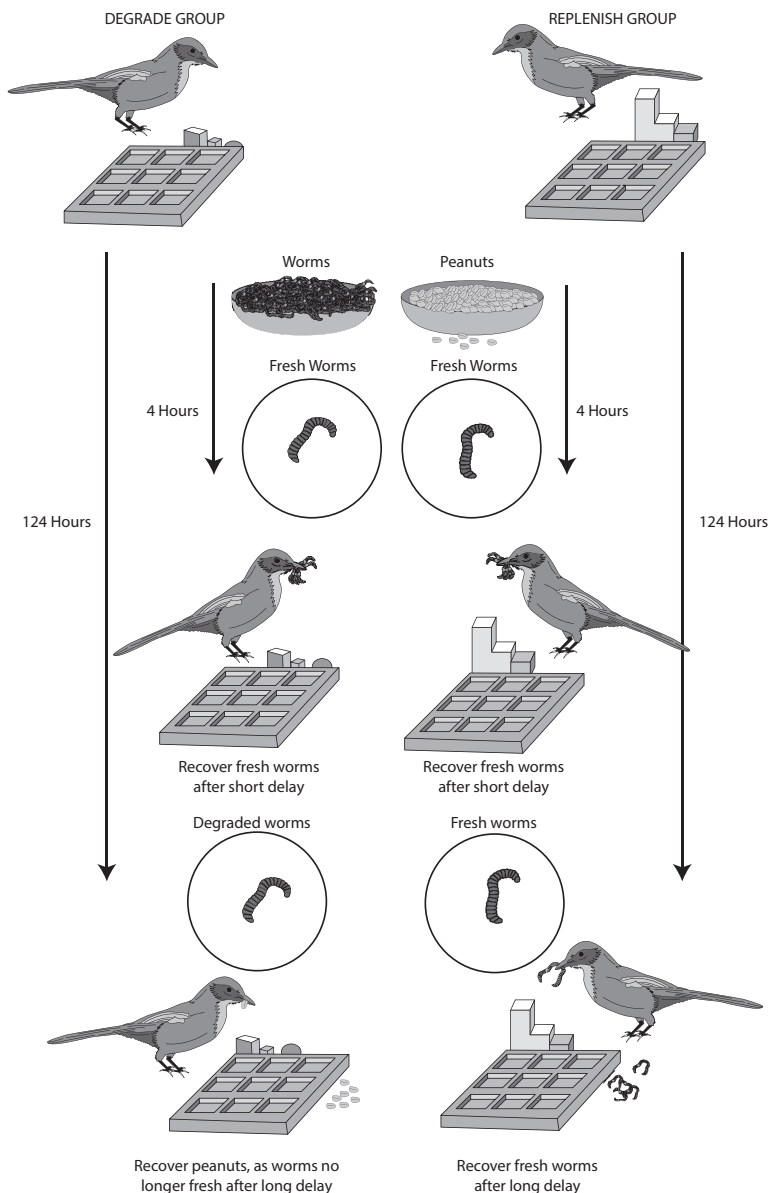


Figure 10.4 Summary of research design for Clayton and Dickinson's (1998) study of whether scrub jays remember what food they cached, where, and when

Source: Artwork by Nathan Emery. Redrawn from: Figure 11.1, p. 229, from Clayton, N. S. (2017). Episodic-like memory and mental time travel in animals. In J. Call, G. M. Burghardt, I. M. Pepperberg, C. T. Snowdon, & T. Zentall (Eds.) *APA handbook of comparative psychology: Perception, learning, and cognition* (pp. 227–243). Washington, DC, US. Used with permission of the American Psychological Association.

passage of time following caching as a cue, birds in the Degrade group recovered larvae if only 4 hours had passed since caching them, and switched to recovering peanuts if 124 hours had passed since caching. In contrast, birds in the Replenish group always recovered more larvae than peanuts because the worms did not perish.

Dozens of experiments have followed up on this work, and it has been replicated and extended to address other interesting questions about memory in scrub jays (reviewed in Clayton, 2017). Clayton and Dickinson's (1998) landmark study is regarded as the first to explicitly establish that a nonhuman species could remember what (food items), where (their location), and when (time elapsed since caching) information, which would appear to constitute "episodic-like memory." This is a preferred term used by many scientists when referring to animals possibly using what-where-when information to guide their behavior. Using this term carries the advantage of scientific caution, but from a comparative or evolutionary perspective it is not particularly helpful. We would not refer to a posterior appendage of a chimpanzee as "leg-like," for example. For tackling evolutionary questions, we prefer to identify the core features of episodic memory and see whether they are present among nonhuman species.

Clever experiments with rats and pigeons suggest episodic memory and, possibly, mental time travel capacities (reviewed in Crystal, 2018; Zentall, 2013; see also Roberts, 2012). For example, in studies modeled after Clayton and Dickinson's experiment with scrub jays, Zhou and Crystal (2011) used radial arm mazes to test whether rats could use what-where-when information when searching for a preferred (chocolate-flavored pellets) over a less preferred (chow-flavored pellets) food. Their results suggest that, much like scrub jays, rats show evidence of episodic (or "episodic-like") memory. We should note that there are other ways of conceptualizing and measuring episodic memory in animals that does not focus exclusively on establishing what-when-where capacities (see Crystal, 2018). Work with rats combining both behavioral and electrophysiological data has provided additional evidence of possible mental time travel in nonhumans. Place cells in the rat hippocampus fire while animals explore mazes, and the co-occurrence of exploration and neural activity appears to be important for forming a cognitive map of the rat's environment (O'Keefe & Dostrovsky, 1971). More recent work using hippocampal recordings of rats has shown that neural activation of hippocampal cells does not only occur while the animals are exploring mazes, but also occurs in the form of sharp-wave ripple activity, as recorded via electrophysiological methods, after the rats have been removed from the maze, during sleep, and during periods of wakefulness (Karlsson & Frank, 2009; Wilson & McNaughton, 1994). These findings raise the possibility that rats are "replaying" activity in the maze after they have been removed. Furthermore, the pattern of neural activity does not necessarily have a one-to-one correspondence with the activity recorded during maze exploration. The pattern of activity may occur in reverse or in a way that is not consistent with any of the paths the rats actually took (Gupta, van der Meer, Touretzky, & Redish, 2010). Corballis (2013) interprets the work on slow-wave ripple activity in rats as being evolutionarily homologous to hippocampal-mediated mental time travel in humans.

It could be argued that the behavioral and neural evidence for mental time travel and episodic memory in rats should be sufficient to seriously doubt, if not refute, that these are uniquely human capacities. However, evolutionary convergence or other plausible alternative explanations could account for the apparent similarity between rat and human episodic memory. This is an interesting theoretical issue in its own right, but may be of less use from the perspective of cognitive archaeology. One strategy for navigating this snag is to more closely examine evidence of these processes among our closest relatives. Which brings us to Santino, a chimpanzee residing at Sweden's Furuvik Zoo. Tatu's eagerness for holiday parties has been matched by Santino's motivation to express his territorial motivation by throwing stones at zoo visitors. Santino was observed stashing rocks at various locations across his enclosure prior to the arrival of the visitors. As the visitors approached, an otherwise calm Santino, perched next to his various weaponry stashes, hurled rocks toward them. Santino's behavior can be interpreted as a form of planning, and thus mental time travel, in a nonhuman species (Osvath & Karvonen, 2012). Naturally, this interpretation of Santino's behavior, or similar examples found in other animals (e.g., corvids), is not met with universal agreement (Redshaw, Taylor, & Suddendorf, 2017; Suddendorf & Corballis, 2010).

Tool use and exchange paradigms

Deferred tool use or exchange tasks provide another experimental approach to examining learning and memory in nonhumans. Orangutans and bonobos will select appropriate tools from an array of useful and useless tools that they can later use to open an apparatus that contains food. The apes reliably do this even when the delay between choosing the correct tool and access to the apparatus is separated by a 14-hour interval (Mulcahy & Call, 2006; Figure 10.5). Chimpanzees also appear to anticipate the need for a specific tool for later use (Dufour & Sterck, 2008, Study 5). In deferred exchange tasks, subjects learn that a specific, ordinary object (e.g., not a tool or food) can be exchanged for food at a later time, and therefore the animal must learn to select the appropriate object when given the opportunity, and remember to bring it in exchange for a food reward. Both chimpanzees and orangutans show evidence for the capacity for deferred exchange (Osvath & Persson, 2013; see also Dufour & Sterck, 2008). Furthermore, in an experiment analogous to the caching experiments done with corvids, great apes (bonobos, chimpanzees, and orangutans) used what-where-when information in deciding whether to pursue a rapidly perishable item (frozen juice) or a hardier one (grapes) (Martin-Ordas, Haun, Colmenares, & Call, 2009).

Fieldwork with chimpanzees

Scientists studying wild chimpanzees have also reported several different types of future-oriented behaviors. In her seminal work on the tool using behaviors of Gombe chimpanzees, Goodall (1964) noted that chimpanzees sometimes manufactured several tools and transported them to the termite nest, where they were used one at a time. Chimpanzees in the Tai Forest have also been reported to transport

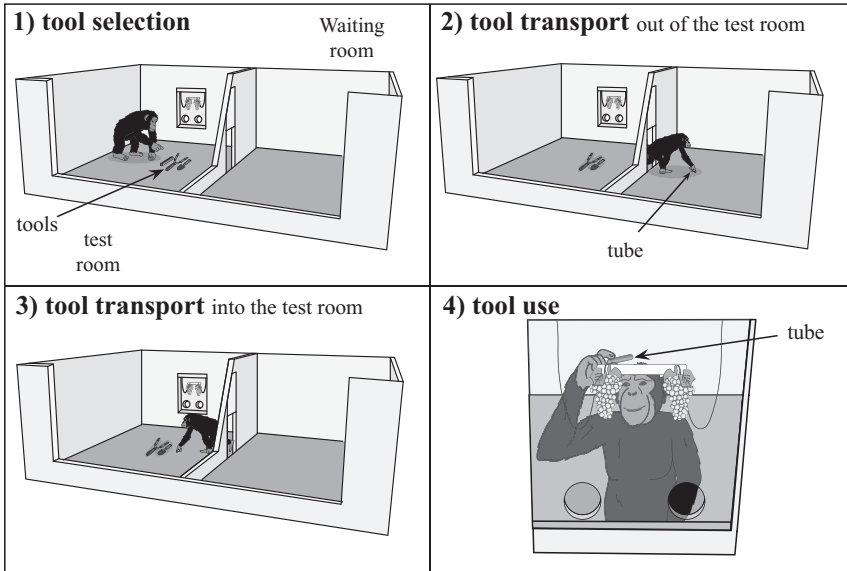


Figure 10.5 Procedure for the tube task used in Mulcahy and Call's (2006) test of bonobo and orangutan capacities to save tools for future use. The apes were first trained that a specific tool was required to access food in the test apparatus (depicted in panel 4). Once they reliably used the correct tool, the apes were moved into a test room (panel 1) and were allowed to select one of four tools to keep (only one of which could possibly be used to acquire the food). The apes were then led out of the test room (panel 2) where they remained for at least one hour while the test apparatus with the food was removed (see original experiments for details of variations on the procedure). After the delay period the food apparatus was replaced in the test room and the subjects were allowed to return (panel 3) and, if they remembered, use the tool to acquire food (panel 4).

Source: Redrawn from Nicholas J. Mulcahy, Joseph Call, May 19, 2006, "Apes save tools for future use". *Science*, 312(5776), 1038–1040. Reprinted with permission from AAAS.

tools to nut-cracking sites that are out of view (Boesch & Boesch, 1984). In the Goulougo Triangle, chimpanzees use tool sets comprising a puncturing stick to open tunnels into a subterranean termite nest and, after extracting that tool, insert a flexible fishing probe to extract the termites (Sanz, Morgan, & Gulick, 2004). Chimpanzees arrive at the nest either carrying the raw materials for both types of tools or with only fishing probe materials. This strategy makes sense as puncturing tools that have previously been deposited can be reused for several months and alone would not be sufficient to accomplish the task. Byrne, Sanz, and Morgan (2013) suggest this behavior is diagnostic of planning and indicates the chimpanzee's anticipation of future needs. Manufactured tools are also transported between tool use sites and conserved during rest periods between tool use bouts at different localities (see Figure 10.6). Chimpanzees also exhibit planning in more generalized



Figure 10.6 Chimpanzees manufacture tools for particular functions and may transport these between tool use sites. An adult female chimpanzee in the Goualougo Triangle was observed carrying a termite fishing tool into the forest canopy where she constructed a day nest. The photo sequence shows her holding the tool in her mouth just after constructing a day nest, reclining in the nest while holding the tool, and continuing to hold the tool while sleeping in the nest. Tools that require specific materials or require modifications are more likely to be conserved than those that do not.

Figure 10.6 is to be made available as a downloadable e-resource at www.routledge.com/9781138594500.

Source: Photos by Crickette Sanz.

foraging contexts. For example, researchers at Tai have found that the chimpanzees select their nest building and nest departure times to facilitate access to a breakfast of ephemeral fruits (such as figs) in comparison to when they proceeded to feed on fruits that were more consistently available (Janmaat, Polansky, Ban, & Boesch, 2014). Such observations support a homologous origin of episodic memory for future events within the ape clade.

Testing adaptive hypotheses: implications for cognitive archaeology

A truly evolutionary perspective of learning and memory processes needs a critical view that tests, rather than speculates on, their specific adaptive benefits. Animal learning and memory researchers have adopted such terms as “adaptive specializations of learning and memory,” “constraints on learning,” and “prepared learning” to explain phenomena that appear to reflect the influence of natural selection on how learning and memory processes are expressed (Domjan & Galef, 1983; see Macphail & Bolhuis, 2001, for critique). Many examples exist in the literature on classical (Pavlovian) conditioning. Although this nearly ubiquitous form of learning involves general principles of stimulus association and response acquisition, the ways in which associations form may reflect ecological circumstances of the study species. For example, prey are more likely to be conditioned to the cues of natural predators than to just any animal, nausea is more likely to be conditioned to gustatory cues than to audiovisual ones, and conditioned sexual responses are more likely to occur to stimuli that include species typical visual cues than arbitrary ones (reviewed in Krause & Domjan, 2017). These and other findings have been called “adaptive specializations of learning” because they seem to facilitate conditioning, and, possibly, survival and reproductive fitness. They definitely facilitate conditioning, a proximate level observation, but whether they bear the mark of natural selection, and therefore truly reflect biological adaptations, is another type of question.

Testing for the adaptiveness of learning and memory, or any biological trait for that matter, requires using specific methodologies and sources of data (Krause, 2015b). These include but are not limited to fossil (and archaeological) specimens, experimental evolutionary methods, quantitative and molecular genetics, and comparative studies. Another approach, popular in evolutionary psychology, has been to use a heavy dose of evolutionary logic and inference, and, often, broad speculation. Similarly, the field of cognitive archaeology, in bridging cognitive psychology with archaeology, requires linking inferences between the cognitive processes of modern humans with ancient artifacts (Coolidge & Wynn, 2016). It is our position that the field of cognitive archaeology should and can incorporate multiple sources of data, such as comparative studies with nonhumans, to test for the adaptive and evolutionary bases of human learning and memory. In doing so, we can replace inferential steps with empirical data.

With regard to fossil and archaeological records, we can look to tool use in extinct hominins for insight into memory capacities. Stone tools provide another avenue of

examining the origins of anticipation and planning in humans. The archaeological record predates the origin of modern humans, and there is increasing evidence that several species of hominins were using tools during the Plio-Pleistocene. Rather than focusing on just the final forms of tools, archaeologists often examine the process of lithic reduction during tool manufacture. Such a sequence starts with selection of raw materials, and then proceeds to preparation of the core and removal of flakes. It may also involve retouching. However, it is not always clear which artifacts represent desired end-products versus byproducts (McPherron, 2013). The archaeological record clearly shows that the ability to select particular stone materials to manufacture tools, transport them across the landscape, and maximize productivity of these materials dates back millions of years to the Oldowan assemblages (Braun et al., 2009; Delagnes & Roche, 2005; Stout, Quade, Semaw, Rogers, & Levin, 2005).

Genetically based studies give us further clues into the evolution and adaptive nature of learning and memory. Experimental evolutionary studies with fruit flies have shown how learning is influenced by artificial selection (Dunlap & Stephens, 2014; Reif, Linsenmair, & Heisenberg, 2002), and these findings may parallel circumstances in which selection acts upon phenotypic variation in learning and memory processes within and among natural populations. Obviously, methods used with fruit flies cannot be replicated with humans. However, quantitative and molecular genetic studies of humans are feasible, and they can reveal important information about possible effects of natural selection on learning and memory. For example, Kalmady, Venkatasubramanian, Arasappa, and Rao (2013) conducted an evolutionary genetic analysis of the MEF2C gene, which is known to be involved in hippocampal-based contextual fear conditioning. Their analysis indicates positive selection (increased frequency) on four codon sites for this gene among humans, and in comparison with other mammals.

Comparative studies of behavioral and brain characteristics are excellent sources of data for making inferences about the evolution of learning and memory (including episodic memory; Murray, Wise, & Graham, 2017). Species comparisons can help answer questions about the origins, phylogenetic distribution, and role of convergent evolution in memory. Neural substrates within the medial temporal lobe, particularly the hippocampus, are critical for binding events with spatiotemporal context and for mental time travel (Kragel, Morton, & Polyn, 2015). These substrates are shared by human and nonhuman species alike (e.g., rodents and primates; Thome et al., 2017). Behavioral studies with nonhumans, as reviewed in this chapter, suggest that the capacity for episodic memory and mental time travel is widespread, and this has implications for how cognitive archaeologists interpret the evolutionary bases of human memory.

Conclusion

Learning and memory processes such as those listed in Table 10.1 are distributed throughout the phylogenetic continuum. Adaptive modifications occur, but the basic building blocks are found in many animals. Here we have chosen to focus

on episodic memory, in part because it has been previously regarded as something uniquely human (Suddendorf & Redshaw, 2017). But maybe this is not so. For cognitive archaeology, it would be scientifically misleading to presume that episodic memory is uniquely human, and to then proceed with this assumption when interpreting how cognitive psychology and neuroscience fit with archaeological data. We might expect that episodic memory processes would be most well-developed for important fitness-related tasks in nonhuman species. Whereas in humans, it may have broader applications, not always strictly tied to fitness concerns. For example, work on the survival processing effect (Nairne et al., 2007) is based exclusively on a language-specific task. However, given that there is evolutionary continuity in episodic memory capacities, including mental time travel, its adaptive significance should also be interpreted broadly, rather than with regard to a single species (e.g., humans), and historical narratives about the evolution of human memory that emerge from work in cognitive archaeology should reflect shared ancestry.

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11

RECONFIGURING NATURAL SEMANTIC METALANGUAGE FOR A DEEP COGNITIVE ARCHAEOLOGY

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Overview

Following W. V. O. Quine (1960), to understand a people's thoughts, experiences, and worldviews one has to have a secure grip on the particulars of their language (i.e., lexicon, syntax, semantics). This boils down to asking a people about their understandings as framed in their natural language and comparing answers to the analyst's own linguistic resources for understanding related phenomena. But what about adopting such a gambit for species that preceded modern humans? An approach analogous to the one described by Quine for modern language speakers, but now framed in a Darwinian context and applied to nonhumans that preceded us evolutionarily, could enable an analyst to understand a species' linguistically formulated "mental resources" (e.g., conceptual, cognitive, experiential, and semantical) that undergirded their behavior in relation to environmental and social contingencies. This chapter (a) posits the evolution of a generic and innate Language of Thought and Experience (LOTE), a *neuro-mental apparatus* that is responsible for consciousness, meaningfulness, and adaptive behavior; and (b) suggests a method of formulating and empirically investigating its natural history and function among "evolutionary creatures" writ large.

Natural Semantic Metalanguage (NSM) refers to a long research tradition in comparative linguistics that began with Anna Wierzbicka (1972) and her colleague, Cliff Goddard (Goddard, 2008, 2011, 2012, 2018a, 2018b; Goddard & Wierzbicka, 1994, 2002; Wierzbicka, 1992, 1993, 1996, 1999, 2004, 2009, 2011, 2014). It consists of an inventory of semantic primes of universal scope and their corresponding lexico-syntactic and lexico-semantic modes of combination. Primes involve units of meaning, mainly words but possibly including phrases, and prefixes/suffixes forming bound morphemes that function as verbal materiel. Other components of NSM

include grammatical frames or “valency options” tied to each semantic prime, as well as complex categories and networks of meaning termed “semantic molecules” that are formed by connecting semantic primes together. Serving as a good Quinean tool, conventional NSM explications of a people’s natural language understanding of their world tease apart and elucidate the mental processes and experiential correlates germane to human psychology.

NSM will be used here as an initial framework for considering both human and nonhuman mental, semantic phenomena embodying consciousness (i.e., LOTE). This perspective was prefigured by Goddard, Wierzbicka, and Fabrega (2014), who considered the last common ancestor of man and apes (LCA) as an initial focus of analysis leading to humans. Herein, I will extend the conventional NSM approach so as to encompass activities and processes embodied in the brain/mind or neuro-mental apparatus of evolutionary creatures in general (i.e., nonhumans and humans). NSM is a well attested conventional method for describing and comparing the linguistically meaningful contents of consciousness immanent in words or segments of modern language among *Homo sapiens*. Here, NSM is repurposed as a model of the dynamic evolutionary machinery in evolutionary creatures that is responsible for adaptive behavior. As such, this chapter reconfigures the NSM approach to meaning so as to formulate the evolutionary origins of a LOTE neuro-mental apparatus that is posited to undergird the very deep archaeology of human cognition as formulated in this volume.

Although the particulars of NSM (and my extensions of it) are unique to this chapter, similar ideas have been proposed by others. For example, Gordon Burghardt (1991, 1997, 1999, 2009) has been responsible for emphasizing *critical anthropomorphism* as a methodological tool in the comparative study of animal behavior. Like other cognitive ethologists (e.g., Griffin, 1998; Smith, 1991; Ristau, 1991) he recommends that the principles and tenets of individual and social psychology presumptively responsible for the adaptive behaviors of humans (e.g., subsistence, mating, competition, predator avoidance, and even play) be used to formulate and test hypotheses motivating analogous behaviors in nonhumans engaged in related biological activities. The important proviso is that, on one hand, such hypotheses need to reflect evolutionarily inherited natural affordances and, on other hand, prevailing environmental obstacles, which in combination have posed constraints on the species’ natural quest to persist and reproduce in its current ecology. In the context of activities involving biological problem solving, a critical anthropomorphic approach formulates experiments whose results broaden inferences about how and why animals behave (i.e., conceptualize or “mentalize”) in the ways they do. Based on such ideas in cognitive ethology (for background see Burkhart, 1997, 2005) and related behavioral sciences (e.g., Neuringer, 2002, 2004, 2014 in comparative psychology, Merker, 2004, 2007, 2009, 2012 in consciousness studies, all discussed later) I propose that aspects of the theory and method of NSM can play a role in understanding the evolution of LOTE on this planet. In effect, NSM is here presented as a candidate theory and method that can be used to study and formulate mental phenomena (cognitive archaeological concerns) from an extended evolutionary standpoint.

NSM

All speakers of a natural language formulate and express their thoughts through shared words, phrases, and units of meaning in patterns of grammatical connect-edness that they arrange in different language-specific ways. In the context of cross-cultural differences involving language, conventional NSM analyses provide a systematic and sustained comparison of commonalities and differences in the concepts and meanings embodied in a people’s linguistically formulated psychol-ogy and worldview. Basically, analyses focus on comparing how any natural lan-guage (L1, L2 . . . Ln) speaker represents, comprehends, experiences, and behaves in relation to identical or similar targets that can include physical or natural objects, social circumstances, relatives or persons, and ideas about values, purposes, and existence.

NSM consists of 65 or so irreducible semantic primes. In conventional NSM these semantic primes function as the atoms of meaning. All speakers of natural languages the world over are presumed to base their thoughts using this inventory of NSM primes. As Table 11.1 (after Goddard et al., 2014) shows, however, NSM is more than just a lexicon. Primes embody logical entailments that specify the pos-sible ways (valency options) in which they can be combined with one another to represent ever more complex concepts.

The successful application of the NSM approach to understanding the com-monalities and differences across human languages suggests that its inventory of semantic primes and their patterns of combination exemplifies shared categories and principles embedded in the “evolutionarily language-prepared brain/minds” of *Homo sapiens*. This invites further questions about the origins and natural history of the structures responsible for language, cognition, and experience. As such, NSM arguably could be used as a model for how the meaning-making and meaning-affirming neuro-mental machinery embodied in the governing apparatus of *Homo sapiens* brains has evolved. Put differently, and when cast in a Darwinian framework, NSM can serve as a tool for the analysis and evolution of LOTE in evolutionary creatures, writ large.

Table 11.1 Sample semantic primes

Substantives	I, YOU, SOMEONE, SOMETHING/THING, PEOPLE, BODY
Relations	KINDS, PARTS
Quantifiers	ONE, TWO, SOME, ALL, MUCH/MANY, LITTLE/FEW
Evaluators	GOOD, BAD
Descriptors	BIG, SMALL
Mental predicates	KNOW, THINK, WANT/DO NOT WANT, FEEL, SEE, HEAR
Possessions	(IS) MINE
Actions	DO, HAPPEN, MOVE

Where to begin

The field of consciousness studies has considered a wide span of animal precursors to human mental phenomena that presuppose many varieties (or antecedents) of awareness and experience. Examples include Dennett (1987, 1991, 1995), Merker (2004, 2007, 2009, 2012), Koch (2004, 2012), and LeDoux (1996, 2003, 2008). Of special interest for this volume is the work involving Neanderthals by Wynn and Coolidge (2012; see also Chapter 14, herein) and Fabrega, (2013; see also Goddard et al., 2014 for hominins and, later, archaic humans).

Revonsuo (2006) provides one possible starting point for considerations about LOTE in nonhuman animals:

The mere occurrence or presence of any experience is the necessary and minimally sufficient condition for phenomenal consciousness. For any entity to possess primary phenomenal consciousness only requires that there are at least some patterns – any patterns at all – of subjective experience *present-for-it*. It is purely about the *having* of *any* sorts of patterns of subjective experience, whether simple or complex, faint or vivid, meaningful or meaningless, fleeting or lingering.

(Revonsuo, 2006, p. 37)

Feinberg and Mallatt (2016) develop these ideas further, considering the mental stuff that thousands of millions of years later culminated in human language. Outlining the bare essentials supporting such mentalization, broadly construed, has also been the central preoccupation of Derek Bickerton's studies involving evolution of language.

In both thought and language you need to know the precise relations between the things you're talking or thinking about – who (or what) did what to who (or what), for whom (or what), with what, how, when, where and very often why. If you don't get those relations right, all you've got is word-salad or thought-salad. But if what you're doing is thinking, you yourself already *know* those relations; they don't have to be spelled out. And if you're talking, the same applies. But if you're talking, someone is usually listening, and that someone *doesn't* know and can't know unless such relations are overtly spelled out. That's a problem for humans. It's not in any way a problem for brains.

(Bickerton, 2014, pp. 12–13)

Perhaps even more broadly there have been the various considerations tied to the representational theory of mind or RTM (e.g., Fodor, 1975, 1983; Bermudez, 2003) that propose that thinking and knowing involve the operation of sentence-like formulae in an internal system of representation. Both RTM and NSM concern the structures of information handling (in brains/minds) that

come into play as mediators in the sequence between sensation, perception, decision, and action. And both my reformulated NSM and RTM posit that overt behavior is the endpoint of causal chains whose links are unobservable (i.e., mental) events.

The basic thesis of this chapter is that when reformulated and extended, NSM can elucidate the origins of LOTE in sentient life on this planet. That said, to accomplish an empirically satisfying connection between the conventional categories of mental phenomena across different species obviously requires a selective and restrictive account of such phenomena as manifest in *Homo sapiens* behavior. Consequently, culturally and psychologically rich stuff gripped through the quintessentially human-centered NSM has to be simplified and reduced in scope so as to integrate with the comparatively lean, predominantly descriptive, and potentially evolutionarily consequential principles undergirding cognitive ethology, comparative psychology, consciousness studies, and philosophy of mind.

The evolution of consciousness and mentalization

The topic of cognition and experience in animals has been a vexatious and controversial matter (see Bekoff, 2002, 2007; Bekoff, Allen, & Burghardt, 2002; Burghardt, 1997, 2009; Foster, 2016; Goodall, 1986a, 1986b, 1988; Griffin, 1976, 1981, 1992, 1998; Hurley & Nudds, 2006; de Waal, 1996, 2016; Safina, 2015; Allen & Bekoff, 1997; Feinberg & Mallatt, 2016 as favored sources). In his account of the “dangerousness” of Darwinian ideas, Dennett (1995; see also 1987, 1991) discusses metaphysical dilemmas about scientifically important questions that need to be heeded in the study of consciousness and mental phenomena – for example, how the activities of macromolecular proteins can be equated with and distinguished from the causal powers of sentient agents. His discussion of the logic of molecular biology leads one inexorably back toward the birth of agency; namely, when the seeds of intentional action enlaced in macromolecules evolved sufficient complexity and staying power to resemble/become representation, deliberation, reflection, and decision. Dennett’s reasoning here seems consistent with that of Chalmers (1995, 1996), who has suggested that awareness and experience could add something fundamental to the ontology of physical theory (e.g., mass, charge, space, time). Chalmers even hints that experience itself may qualify as a feature of the universe. Feinberg and Mallatt’s (2016) compendia on the origins of consciousness does not reach that far back, but it does provide an account of origins and natural history of consciousness beginning during post-Cambrian times and ranging through vertebrate, mammalian, primate, hominin, and eventually *Homo sapiens*.

Dennett has in several publications (e.g., 1987, 1991, 1995), and most comprehensively in his recent compendium (2017), highlighted the conundrums inherent in a natural history conception of mental life as contextualized in this chapter. Stated succinctly, this asks: At what point can the forms of conventional ideas about mental phenomena among *Homo sapiens* be imputed not just to immediate and post LCA ancestors of *Homo sapiens*, but even beyond hominins onto nonlinguistic

evolutionary creatures, ending up with and including the “agency and function” of complex macromolecules? According to Dennett (1995) a potential attribute of consciousness such as intentionality does not come “from on high” but percolates upward from “down below”; specifically, from initially pointless and mindless algorithms that gradually acquire definition, relevance, and hence meaning through reinforcement and natural selection.

Dennett’s formulation of the processes responsible for origins of consciousness is not that dissimilar from Bjorn Merker’s (2004, 2007, 2009, 2012), which is situated in a totally different phylogenetic and strictly defined biological context. For Merker, consciousness can plausibly be ascribed to (at least) mammals and higher vertebrates. He emphasizes that in the search for the evolution of human language and consciousness in particular, homology is not necessarily the only relevant construct for explaining evolutionary dicta. Nonhuman analogues of systems of communication are also potentially important. Human psychology traits do not necessarily represent “heirlooms handed down in phylogeny” but may instead conform to analogous, independently evolved traits in widely separated species. For example, Merker (2012) describes the evolutionary creatures who exhibit consciousness, including earlier representatives of genus *Homo*, as singing and speaking species. As in the present proposal, Merker handles consciousness as a more-or-less automatic and entirely evolved biological function. In contradistinction to ideas about the function of consciousness as directing and mediating higher “mental” behavior, his consciousness centers around the acquisition and requirements of evolutionarily adaptive and large complex brains in mobile animals.

For Merker, then, consciousness does not necessarily function to provide meaning, purpose, or information handling (in the executive function sense) but simply assists in maintaining a physically stable frame of reference that allows organisms to organize their mobile behaviors. This enabled the disentangling of sensory/perceptual information about the world from incoming information generated by the movements of the animal. Vertebrate brains coped with a need to dissociate such sources of information so as to better integrate them into functional behavior (i.e., connecting complex afferent and motor activity adaptively), and an outcome of this process was the evolution of consciousness. Moreover, Merker’s consciousness is said to have emerged in the context of increasingly larger, more complex (e.g., topographically layered, hierarchically arranged), and centrally organized brains of vertebrates, which among mammals come to play command functions through an expansion of the dorsal pallidal wall of the vertebrate forebrain.

Based on relevant literatures in the social, evolutionary, and cognitive sciences, Merker proposes two rationales through which one can explain the evolutionary transition during the pivotal phase (from roughly 600,000 to 150,000 years ago) extending from late *Homo erectus* on to archaic and modern humans. One is stochastic, passive, and mechanical and is based on computer-simulated modeling of utterances as information strings. The other is semantically substantive and directed, keyed to song routines centering on distinctive types of social settings and problem-solving situations. Merker does not highlight nor presume meaning, nor for him is language formulated as deliberative or agentive – it is mechanical and involves the

iteration of strings competing in a “learner bottleneck.” Over time such strings get passively segregated into settings and circumstances because of formal resemblance devolving from selection factors, and language advances (see also, Hurford, 2007, 2012, 2014).

Early *Homo erectus* (approximately one million years ago) is hypothesized to have communicated through song, but then eventually by conditioned association materialized in spoken utterances. In a “top-down formulation” of hominin language and cognition, larger structures of meaning conveyed mimetically or in sound (e.g., strings, utterances) are presumed to separate out into syntactical forms among representatives of genus *Homo*. These are broken down and come into play, establishing more explicit string/utterance connections with settings, circumstances, and activities (see also Knight, Studdert-Kennedy, & Hurford, 2000). Although Merker’s (and Hurford’s) formulation suggests that a “mindless” concatenation of strings is responsible for the stuff of consciousness, his position tentatively connects with the mental states of sentient creatures wherein analogous strings of thought competed in a process that ultimately consolidated as conceptual and eventually deliberative thought.

Tomasello’s (1999, 2008, 2009, 2014) views on the origins of human thinking do not explicitly address consciousness per se; however, the relevance of consciousness is implicit in his formulation of hominin evolution. Tomasello’s emphasis is on the imperatives of social communication as well as the sharing of emotions and information. In other words, what Merker’s singing species accomplish through their activities involving communication (e.g., respecting territory, mating, parenting) can be likened to the implicit social psychology of Tomasello’s views (based on controlled experiments of chimpanzee behavior) on the origins of human thinking.

Merker’s account, taken with related ideas discussed by Hurford, raises obvious questions about the mental activities of evolutionary creatures that may exhibit forms of consciousness, awareness, and meaning. Like Tomasello, he ultimately points to a sort of “social psychology” of context or mode of selection. However, Merker’s account involves birds, mammals including whales, and primates who communicate in song-like routines that are partly innate and partly learned through associatively conditioned contextual stimuli. Such evolutionary creatures remember, modify, update, learn, and adaptively implement when and how to use their consolidated routines.

Feinberg and Mallat (2016) place the origins and diversification of animal forms of consciousness as starting during the Cambrian explosion around 560 to 530 million years ago that resulted in all known animal phyla. Like Merker, they argue that the evolutionary history involving consciousness was a product of complex nervous systems and brains. Accordingly, all vertebrates have exhibited some pure “end state” consciousness, but the large memory component that became manifest in mammals and birds when the anatomical template switched from lower midbrain to midbrain to the cerebrum offered something far more comprehensive. The consciousness of the distant senses (exterior world or end-state consciousness) initially existed without emotions, although during evolutionary history consciousness changes from exteroceptive to affective and experiential. This in turn was followed by a fuller

sentence that included affect and was equated with what one can describe as an animal's unified world of personal experiences. Feinberg and Mallat suggest that these developments were associated with qualia, images of an external world mapped around vision, olfaction, audition, gustation, and the haptic sensations of touch. In short, Feinberg and Mallat indicate that all vertebrates past and present have exhibited affective consciousness as well as a mapped representation of the external world associated with exteroceptive consciousness. And further, precursors of such capabilities are to be found among arthropods (including insects and crabs) and cephalopods.

A tadpole that swims to avoid chemicals placed in its environment by a researcher *could be said* to be exhibiting a state of consciousness that is responsible for its avoidance behavior (Kiesecker et al., 1999). Of course, the credulity of any good behaviorist would be strained by such talk, especially if it posited that the tadpole acted volitionally, let alone deliberately. Nevertheless, Neuringer (2002, 2004, 2014; Neuringer & Jensen, 2010) has developed a formulation based on principles of reinforcement and associative conditioning that would account for the tadpole's response to the "discriminative stimuli" of toxicity as volitional behavior. Such a formulation is consistent with that of Heinrich (1995) in discussing the seeming insight exhibited by ravens in his controlled study of their problem-solving behaviors, which strongly suggests the use of reasoning principles and related conscious phenomena. More sophisticated examples of such volition would involve gestures as discussed by Tomasello and Call (1997) and behaviorist scenarios as described by Shettleworth (2010, 2012), Dickinson (2008, 2011), Call (2006, 2013), and Call and Santos (2012). I am here proposing that all such directed and seemingly purposeful behaviors suggest scenarios of nonhuman forms of consciousness, meaning, cognition, and experience amenable to a modified and extended form of NSM analyses of neuro-mental phenomena.

On probing the neurobiology of consciousness

The "new" science of consciousness is based on emerging ideas, methods, and empirical documentation of how human brains decipher, record, and handle sensory-motor stimulation from the environment. It draws on endogenously accumulated (i.e., internal and brain-based) substrates responsible for perception, memory, thought, and imagination that undergird and mediate the organization of behavior (Edelman, 1989; Baars, 1997, 2002, 2005; Dehaene, 2014). A principal "target of interest" in this neurobiology of consciousness involves the role of an amalgam of brain networks, mechanisms, and processes that are presumed responsible for mental phenomena (Churchland, 2013). While virtually all experimental work involving the neurobiology of consciousness is based on humans, it is sometimes explicitly acknowledged that analogous mind/brain activities (with due allowances for differences in content, complexity, and scope) describe the organization, function, and goals of the adaptive behavior of the evolutionary creatures that preceded *Homo sapiens*. For broader considerations see Donald (1991, 2001, and herein), Dennett (1995), Edelman and Tononi (2000), and Edelman, Gally, and Baars (2011).

Bloom's (2004) and Dehaene's (2014) conventions about consciousness generally distinguish natural, adaptive problem solving, a so-called functional consciousness, contra pure awareness or experience. According to Bloom and Dehaene "access consciousness" refers to the "poisedness" or availability (as per verbal reports) of a person's mental state contents of ongoing sensory-motor stimulation, perception, and action. It represents a component of states that enables free use of wakefulness, attention, and reasoning, which when taken together are responsible for the directed or "rational" behaviors owned by and accessible to a doer. Access consciousness is immanent in linguistic representation and the behavior of a person who is planning, goal seeking, or intentionally communicating. It constitutes a descriptive functional account of the workings of a person's evolutionarily inherited neuro-mental apparatus, which is consistent with formulations of what it is that consciousness and awareness "are" and "do" for evolutionary creatures including persons. On the other hand, "phenomenal consciousness" describes the subjective character of felt mental activity typical of *Homo sapiens*. In the event, if put in the "internal language" of a speaker (e.g., as per NSM explication), it would approximate Bloom's first-person formulation of subjectivity (as classically described by Vygotsky, 1934/1962).

As an aside, it should be underscored that Bloom's and Dehaene's conception of access consciousness in *Homo sapiens* is far removed from Chalmers' "hard problem" about consciousness (i.e., how is subjectivity physically produced) or even from Nagel's (1974) mental and existential questions raised by asking "what it is like to be a bat." The primary focus of this work (e.g., Baars, 2005; Dehaene, 2014) is on the higher cortical areas of the brain that are held to situate the information processing responsible for access consciousness, awareness, and mentalization.

NSM, consciousness, language, and experience

Feinberg (2012) contends that consciousness is a neurobiologically local event that is specific to complex neural organization. It constitutes phenomena that are weakly emergent, non-reductive, and physicalistic (construed and termed here as brain/mind or neuro-mental phenomena). Meanings and consciousness exist as expressions or correlates of processes taking place in complex brains/minds. Likewise, it is reasonable to propose that neuro-mental happenings modeled through NSM's semantic primes and the principles in terms of which they connect with one another ("valency options") described emergent phenomena coming from (or correlated with) processes/activities situated in hierarchically complex brains of evolutionary creatures. Like consciousness then, meaning (semantics) is likely inherent in complex brains. As another aside, one is left with a tantalizing question: If meaning and consciousness, which to us today are relatively contrastive ideas and seemingly germane to different types or grades of evolutionary creatures, both constitute emergent phenomena that came together exhibiting seemingly similar features, then how ("really") different is each from the other, and when and where did they emerge/diverge/expand in the timelines of evolutionary creatures?

From Quine (1960) I infer that skeletons of meanings have a long history on planet earth and embody territories that are ready to be mined. Viewed in strict biological terms, our inherited neuro-mental machinery has a history of natural selection on this planet. It shapes categories and principles for connecting meanings that enabled and elaborated cognition among evolutionary creatures. The rationale, theory, method, and function of the NSM tradition provides a way for doing that “mining” among natural language speakers and if properly reconfigured could accomplish the task of helping formulate and describe the “insides” of experience and meaning among other evolutionary creatures. Specifically, the neurocognitive materiel of brain/mind in human and nonhuman evolutionary creatures, including precursor ancient varieties of such materiel as analyzed by Feinberg and Mallatt (2016), could potentially be modeled by properly composed sets of NSM inventories of categories and combinatorial principles determined by and keyed to a creature’s behavioral ecology. As such, the cognitive (brain/mind) aspects of behavior even in ancient species might on principle be inferred if the appropriate behaviors of their contemporary representatives were to be tested.

Put in interrogative terms: What might (even must) have been happening (e.g., biologically, psychologically, experientially) when early evolutionary creatures began to acquire the capacity to solve adaptive problems? If such a capacity for directed behavior and meaning coincides with a capacity for consciousness, then how might one understand its nature “back then”? And, more problematically, how could one enter its space and realistically ponder its substance? That said, Feinberg and Mallatt (2016) do not presume that much cognitive work was being done by, or is reflected in, the behaviors of ancient creatures. However, one can suggest, like Dennett does, that even “complex molecules” in the soups of the earliest pools of going-on-to-be animate materiel on planet earth prefigure or actually exemplify precursors of the cognitive and experiential stuff responsible for the behavior of subsequent evolutionary creatures.

Here is what Jon Mallatt related to me would have been relevant if early evolutionary creatures could have been queried:

It may not be too difficult to form a list of the key knowledge because there are a lot of evolutionary constraints that make most kind of animals model the outside world in the same, mostly realistic ways – or else they could not survive. I always focus on the basic evolutionary needs of obtaining food, avoiding predators and all other bodily dangers, and of finding mates and reproduction. The first (and all subsequent) conscious animals had lots of keen senses, especially vision, and were extremely alert in sensing the environment. They had a spatial map of the world around them and used this map to move and navigate in that world. They understood various traits of objects such as near versus far, hard versus soft, good (helpful) versus bad (harmful) versus neutral (and thus can be ignored), self versus non self (crudely, meaning they know whether something is inside or outside their body), and I would even say a basic concept of agency

(whether an object is alive is not, and wants to kill or mate). Knowing what was good versus bad was probably less cognitive than affective or emotional reactions, but [Feinberg] and I say emotions are always consciously experienced so they feed into cognition at some level (learning, etc.). I do not know if being social plays a fundamental role: It seems conscious animals that understand aspects of their environment do not need to be social (though some are).

(Mallatt, *personal communication*, 2018)

Feinberg (2012) and Feinberg and Mallatt (2016) opine on what neuro-mental contents and activities of post-Cambrian evolutionary creatures species would have been like as such creatures competed, ingested material, formed reproductive relationships, solved biological problems of adaptation, and generally tried to survive in their environment. This span of the practical actions of adaptation and reproduction delineates the territory of concerns that Feinberg and Mallatt believe would have been immanent in an evolutionary creature's behavior. As such, they can also serve as a starting point for the reconfigured NSM analysis that I propose. In short, to formulate a cross-species "linguistic psychology" one would have to select or construct a scenario that describes an adaptive problem for evolutionary creatures that they have already (at least given existing circumstances) solved or avoided. This would comprise an analyst's target (T_i) for which he or she would carve out an NSM explication that fits the empirical data based on results of animal studies.

The NSM of Wierzbicka and Goddard is a proven tool for comparing meaningful information in human natural languages. The "virtual" structure residing in the skull of *Homo sapiens* that NSM is a model for likely comprising naturally evolved neuronal networks that correlate with, complement, and express an inventory of semantic categories and principles of organization that embody symbolic, meaningful information. The NSM featured here is made to own a different ontology, epistemology, function, and evolutionary historical identity than the conventional one. When transformed from a descriptive tool for understanding contemporary differences in meaning across human languages to a proxy or model of evolved, innate (brain/mind) structures and machinery responsible for meaning and experience, NSM theory and method is being co-opted to operate as a special behavioral science method for understanding the evolution of LOTE.

The LOTE reflects a neuro-mental structure consisting of innate, naturally selected, and experientially shaped (during development) neuroanatomical templates (networks, programs, etc.) responsible for calibrating, formulating, and producing meaningful activities in terms of which organisms solve biological problems of fitness. Thus far I have argued that using a reconfigured NSM as a scheme that models the neuro-mental structures responsible for LOTE is theoretically reasonable. Put bluntly, this NSM serves as a plausible formulation (e.g., model, proxy) of how evolutionarily ingrained and naturally selected neuro-mental categories and activities (cognitive and linguistic) are represented, processed, and used to influence behavior from the global networks and work spaces located in the cortical regions of the

human brain/mind as well as in analogous work spaces in the brain networks of nonhuman creatures.

Contemplating NSM explications of mentalization in nonhuman creatures

Posited anthropomorphically, this essay presumes that when confronted with threats, opportunities, and options that were risky or affirmative to the health and survival of the subject in question, such evolutionary creatures were engaged in adaptive decision-making and behavior. It is my assertion that a repurposed variation of NSM would be a good tool for cognitive archaeology's study of this matter. In order for an NSM analyst to explicate the behavior of a representative of a nonhuman species he or she needs to unpack and formulate the linguistic, logical, and experiential contents of the evolutionary creature's (neuro-mental) representation of objects, events, and situations that are adaptively relevant to its circumstances. Now, how does one get at the necessary data to do such a thing?

When talking about behavioral and psychological matters native language speakers communicate in an idiom that is intelligible to them and members of their community but is neither transparent nor easily accessible to outsiders. Conventional NSM explanations of commonalities and differences in the meaning of a target behavior or situation come framed in a speaker's *first-person* language that is then teased apart and understood through a method of reductive paraphrase based on natural language utterances of the experimental subject. However, the task faced by an NSM analyst working to understand "first-person" a nonhuman evolutionary creature's psychology for behavior presents profound problems that have resonant ontological, epistemological, and metaphysical overtones.

For such an enterprise the analyst would need to rely on critical anthropomorphic principles of inference (Burghardt, 1997, 1999, 2009). The big (and loaded) question for one seeking any formulation of such nonhuman mentalization is to what extent the existing methodology of comparative psychology provides valid access to the experiential content of neuro-mental activities. How, in other words, can one reasonably formulate an evolutionary creature's actions in terms of *its own* apparent feelings, know how, or thoughts about a behavior of adaptive consequence? Such a matter is artfully discussed in Michael Gazzaniga's (2018) recent account of the intellectual history, evolutionary foundations, scientific reasoning, and philosophical dilemmas tied to explanations of mentalization in a general evolutionary context. But, for present purposes, tangible, explicit, and language-like answers would have to be formulated in appropriate *third-person* explications based on NSM inventories keyed to and determined by the characteristics of a corresponding species' psychology and behavioral ecology.

This is, of course, simply the same dilemma that experimental psychologists have always faced when working with nonhuman behaviors that raise questions of underlying experientially and cognitively relevant processes and mechanisms. In sum, my modified NSM analysis will have to rely on third-person accounts based

on empirical observations. This shift in focus (from a first- to third-person vantage point) must then employ the “as if” or “virtual” characterization of unseen hypothetical (first-person mental) phenomena. Arguably, this methodological gambit of shifting NSM to a third-person contra first-person account actually avoids (at least immediately) many problematic aspects of studying mentalization in general, and consciousness and meaning in particular. The externally situated NSM analyst must construe the matter from a third-person vantage point, documenting that it is “as if” the creatures think, know, feel, want, or prefer things. Virtual phrases or sentence-like fragments relevant to a personalized account of LOTE, but modeled and framed in appropriate (i.e., “safe” third-person) terms, then are what *appear to have been sorted out* through the target’s neuro-mental networks (minds/brains).

At this point, sample NSM explications of the results of animal “experiments” can best help illustrate the potential utility of such analyses. Several explications are presented because they will enable me to better illustrate some subtleties as well as the obvious possible pitfalls inherent in conventional NSM accounts of behavioral scenarios in territories occupied by creatures about which it is awkward and logically problematic to articulate first- versus third-person reasoning. The primary illustration provided here concerns theory of mind and social cognition in chimpanzees. The explication uses only semantical primes attributed to LCA in the publication of Goddard et al. (2014).

LCA theory of mind as modeled by chimpanzees

Consider a dominant chimpanzee (D) located in an enclosure with visible access to a setting that contains a food bundle that, however, was covered and not visible to D. On the distant side of this setting in another enclosure stands a smaller and lower ranked chimpanzee (LR) with visual access to the same area and to whom the food is in principle visible. Both chimpanzees are then released into the setting. Upon release from its enclosure, D exhibited no interest in the location of the hidden food bundle, whereas LR went directly for retrieval since (as reasoned by the researcher) it had seen the food. In alternative trials, the food bundle was not obfuscated from D, who upon release promptly retrieved it with chimpanzee LR simply watching. The experimental procedure was designed to test the theory of mind capabilities of both D and LR.

The NSM explication that follows is meant to make explicit how and why chimpanzee LR chooses or avoids retrieving the food bundle in the presence of D, who outranks it, and who is or is not visually impeded from seeing the food that the experimental subject LR is able to see.

A relatively conventional third-person NSM explication of this scenario then is:

There is a chimp (LR) in a place.

This chimp sees something in this place.

This chimp thinks like this:

This is good; this chimp (LR) wants this inside its mouth.

At the same time, this chimp thinks like this:

There is another chimp (I) here now; this other chimp can see this good thing;
“This other” chimp wants this good thing inside its mouth;
“This other” chimp is big;
“This other” chimp is above this chimp (*me*);
If this chimp (*I*) do something to this thing,
“This other” chimp can do something very bad to this chimp (*me*);
Because of this, this chimp (*I*) cannot do anything to this thing now.

When this chimp thinks like this, it does not do anything to this thing as it wanted.

Note that it is the NSM observer’s third-person vantage point that is being articulated in this explication. She or he proffers a paraphrase of the chimp’s “imagined” first-person perspective.

A meal moth’s feast has been interrupted

Consider now another explication of apparent consternation and alarm in a kitchen where a meal moth whose space around dried vegetable matter has been visibly, abruptly interrupted. It is moving now in quick half circles and arcs in response to being pursued by a housekeeper who is actively swatting at it.

This creature is doing some things here now because it is like this:

It knows some things about the place where it is;
because of this, it wants to do something
like someone can do when this someone thinks like this:

Something bad can happen to me (here?) now.
I cannot not do something because of this now.

Whereas any first-person account of “thinking” would rightly be construed as inappropriate, an NSM analyst surely can attribute situational awareness to the moth as its “knowing something” about where it is and “wanting to do something” because of this.

That said, now let us consider another explication of the chimp scenario as an example of a clearly affirmative first-person account relative to the third-person account previously presented. This explication draws on the content of mental predicate semantic primes in its inventory and then formulates the scenario in an explicitly deliberative way.

There is something good here.

I know it, I can see it.

I want it to be in my mouth.

I want to do something now.

There is another chimp here now.

This other chimp is big; I am small.

He is above me.

He can do something bad to me.

This other chimp can see this good thing.

He wants it in his mouth.

(Because of this) I cannot do anything now.

And, as another example of the first scenario, consider an even more anthropomorphic account that credits a chimp with explicitly metacognitive reasoning capabilities.

Something good is known by someone about good things (*I can see*) to put in its mouth.

Someone else here now knows (*can see*) the same good things to put in (*its*) mouth.

(*I can know what this someone knows because this someone sees the same something I see.*)

This other someone is bigger and can hurt the smaller someone.

(*Because this other someone who is bigger sees the same something, IT CAN HURT ME.*)

The smaller someone (*I*) will not put those good things in (*my*) mouth.

All the chimp scenarios use semantic primes that conventional NSM considers plausible units of meaning for representatives of late *Homo erectus* and archaic humans (Goddard et al., 2014). However, when including the parenthetical fragments, the last example reifies mental predicate semantic primes, proclaims subjectivity, and personalizes the creature's ontology and epistemology in ways that may be tempting, but yet problematic.

NSM explications of ancient nonhuman evolutionary creatures

Consider now the behavior of tadpoles (Ts) in experiments measuring their responses to products of damaged tissues resulting from the attack of predators on other tadpoles that were placed in their ambient water and so contained toxins (Kiesecker et al., 1999). In broad strokes, the observed behaviors of tadpoles exposed to an environment permeated with toxins involves them moving to "healthier" places and can be presumed to represent evolutionarily appropriate health-maintaining behaviors.

This explication of a tadpole is direct and affirmative of its behavior, but overall manages to stay within a third-person vantage point. For contrast, overt first-person and metacognitive accounts are provided as italicized parentheticals.

“This” tadpole is here now (not *I am*).
This tadpole “feels” [senses] something bad now (not *thinks*).
There is something “bad” here now (not *harmful, dangerous*).
This tadpole does not “want” this (not *dislikes or is scared*).
This tadpole does not “want” to be here (not *wants to move away*).

Here is an anthropomorphic first-person account of the same scenario.

[*I am*] in this place now.
[*I*] can see and feel *some* things in this place.
Because of this, [I] know some things about this place.
This place *makes my body* feel bad.
Because of this this *I will move away from this place*.
If someone else [*not I*] is in this place now,
this someone *can know* and do the same.

An even more anthropomorphic and metacognitive account of a tadpole’s avoidance of toxins could go as follows.

*There are many living creatures of one kind in the same place,
something very bad happens to some of these creatures,
because something bad is happening (inside their bodies),
some other creatures of the same kind know this.
They know it because they are in the same place at this time,
because of this,
these other creatures of the same kind do something,
because of this,
after this, these other creatures of the samekind,
are not in the same place anymore.*

Yet another account relying on notions of personal identity, an awareness of death, and “thought” could be:

*If these other living creatures (tadpoles) do not do something it can be like this:
Something very bad will happen to them (their bodies),
because of this, after a very short time they will not be (alive anymore),
these (living) creatures know this somehow,
because something bad happens to them (they feel something bad in their bodies),
they do not want it to be like this,
because of this, they do something (move away) at this time.*

These explications are built on candidate primes and their entailments that an observer might apply to tadpoles based on inferences about their behaviors. They blur the boundary between what an external observer might reasonably surmise (from a third-person vantage point) compared to what the subjects in question might conceivably think or experience in responding adaptively (first-person vantage point). As previously argued in this chapter, it is plausible that there are precursors and continuities in the evolution of consciousness and meaning; nevertheless, to contemplate (let alone propose) that tadpoles (or even chimps) exhibit features of sentience such as consciousness, meaning, and thought that resemble those notions in linguistically competent *Homo sapiens* would be an anthropomorphic blunder fraught with both philosophical and scientific problems.

The history of psychology (most recently, Neuringer [2014]) suggests that observers can infer motivations through actions that are the product of strict reinforcement principles. Although I believe a repurposed NSM has potential as such a method for cognitive archaeology, I have provided various explications to highlight the “problematique” of formulating the linguistic psychology of adaptive behavior for creatures that cannot communicate through first-person words about their world.

Adapting NSM to explore the evolution of mental phenomena

NSM is an established approach in comparative linguistics for analyzing meanings encased in samples of human natural language. It involves dissection of lexical, syntactic, and semantic features. I have suggested here that the brain/mind apparatus that a reconfigured NSM is a proxy of in humans constitutes a Darwinian phenomenon that is itself the product of a long history of natural selection. From that Darwinian point of view: *IF* one assumes that meaning, consciousness, reasoning, experience, and the like constitute semiotic features of life forms that are not unique or special, or that come from above (not from God, but from owning a *Homo sapiens* brain), *THEN* it is reasonable to presume that evolutionary creatures at large exhibit varieties, degrees, levels, and scope of mentalization amenable to the sort of analyses just described here (Gazzaniga, 2018). This implies that the categories, procedures, and rationale of NSM can be used as a resource for research that can shed light on operating characteristics of the structures responsible for cognition, experience, and meaning not only for prehistoric *Homo sapiens* but for analogous functions in other evolutionary creatures.

A user of NSM relies on its theory and method as an *external* framework, a symbolic codebook comprising 65 un-decomposable categories of meaning and their *natural* patterns of connectivity with each other. This framework is used to compare commonalities and differences in meaning that a speaker expresses. In this chapter I have reconfigured the *raison d'être* of NSM: Here it suggests a model (“facsimile”) of internal mind/brain activities responsible for understanding and producing meaning and experience in linguistic terms – in effect, the “machinery” that is responsible for a subject’s LOTE.

When reconfigured as a model of neuro-mental machinery NSM can serve as a framework for reverse engineering the evolutionary contours of psychological phenomena involving thought and meaning across phylogenetic varieties of nonhuman creatures. The reasonableness and utility of this endeavor rest on the use of empirical observations grounded in contemporary scientific knowledge about the behavioral ecology and brain size/organization of representatives of a species. The ultimate validity of this enterprise will depend on how well it can provide consistent, cogent, and affirmative semantic explications that match (support) the adaptive and well attested behaviors of such creatures.

Repeated observations involving a variety of behavioral situations in which representatives of a species behaved adaptively would provide grist for the NSM analyst's mill directed at uncovering the LOTE of the creatures in question. Put directly: An evolutionary creature's data concerning its adaptive contra maladaptive behaviors measured under controlled conditions would constitute a realistic body of information that a user of a reconfigured NSM system would need to explicate. Systematic analyses of such information would triangulate on the neuro-mental stuff undergirding the fitness-affirming behaviors of the creatures studied. As discussed earlier, this tactic is consistent with that of strict behaviorists concerning animal cognitions and motivations that posit "as if" or "implicit" or "virtual" forms of cognition (see Miller, Galanter, & Pribram, 1960, for an early and classic exposition from cognitive psychology). At a minimum it should generate testable hypotheses about incipient, emerging, precursor varieties of first-person vantage point cognition among nonhuman evolutionary creatures.

Although the structures, logic, and operations of natural selection would be uniform across all species, semantic primes and their connectedness or grammar would surely differ across species based on their local ecologies, evolved levels of neuro-mental competence (e.g., complexity and size of brain), and capabilities to avoid extinction. This difference would reflect the affordances responsive to features of the behavioral environments of evolutionary creatures that promote adaptive coping. Eventually, this could even result in the formulation of species-specific semantic categories and principles supporting lexico-semantic and/or lexico-syntactic connections. However, such an approach could also yield a pool of generalizations that over time might accumulate so as to suggest incipient or precursor varieties of first-person vantage points regarding thought, experience, and meaning of the creatures studied. In turn all this could be used to formulate an empirically grounded theory about the evolutionary unfolding of LOTE.

Importantly, pursuit of this slant on NSM need not rely exclusively on the contemporary NSM inventory of primes and their connectedness to each other (semantic/grammatical entailments). Positing new candidate semantic primes and their connections with one another may be necessary for understanding the mentalization activities of evolutionary creatures. The gold standard for such new materiel would be what emerged from the analyses of behavioral routines as per reproduction, health status, etc., in juxtaposition with phylogeny, brain sizes, socially adaptive skills, and ecological constraints instead of the analyst's "purely logical" or experientially

rendered intuitions. This sort of inquiry should eventuate in circumscribing species' categories of meaning (and valency options), forms or levels of consciousness, variables responsible for behavior, and connectedness as keyed to the affordances provided by behavioral environments that were responsible for natural selection.

Vetting new candidate semantic primes and their possible connections for use would likely require experiments involving adaptive matters. Measurable parameters of NSM explication would be connected to measurable parameters of environmental affordances. From these, computational models of the posited neuro-mental competencies and affordances needed for recognizing and solving problems arising as a species confronts hardships could be used to sharpen our understanding of the evolution of adaptive features of a species' LOTE. Of course, some semantic primes and their logical entailments may not have been maintained in the preserved genomes that underwrote the behavior of later taxa or species. As such, the ultimate "anatomy and physiology" of this NSM would be based on empirical information about the behavior of evolutionary creatures as drawn from established research in the social and evolutionary sciences. The determinants, workings, and consequences of forms of consciousness, meaning, cognition, and related behaviors would play out in terms of species-specific environmental features that naturally selected for survival and reproduction. Such a cross-species "linguistic psychology" represents the long-term goal of our reconfigured NSM approach to exploring the evolution of mentalization.

Final thoughts

A Darwinian (natural selection) conception of brain/mind structures necessitates a consideration of antecedent, precursor versions of thinking and feeling phenomena formulated in holistic terms that underscores general constructs – e.g., good, bad; want, do not want. While third-person accounts of animal behavior still predominate in evolutionary science, some recent researchers (e.g., Dickinson, 2008, 2011; Hurley & Nudds, 2006) have probed the boundaries between the strict tenets of a behaviorist comparative psychology on the one hand, and the promise of cognitive ethology on the other. Analyses of adaptive behavior of nonhuman evolutionary creatures based on modification of categories, principles, and methods of conventional NSM but that retain the goal of achieving semantic comparison of similarities and differences (but now across species rather than natural human languages) could lead to varieties of virtual lexical and lexico-syntactic connected patterns and categories of thought that when provided with appropriate constraints and limitations pass into early or virtual varieties of first-person accounts.

At its most abstract level this chapter asserts that methods from disciplines like psychology and linguistics can be adapted for use in cognitive archaeology. NSM has served as my example. More specifically I believe that when reformulated and extended, NSM could shed a new light on the origins of LOTE if the appropriate behaviors of their contemporary representatives were to be tested. That said, this

is a preliminary work that is suggestive of a possibility, and I have attempted to be transparent about a wide range of possible issues and pitfalls.

A popular thesis is that human mental phenomena including language, thought, and experience as we know it originated during a relatively compact transformative series of events starting with the Upper Palaeolithic era. This took place in concert with larger and uniquely anatomically configured brains that were genetically prepared for forms of cognition, language, and human culture. And these brains were unique across later hominins or early representatives of genus *Homo*. One can propose, instead, a more protracted series of events starting sometime after LCA, approximately two million years ago, as was done by Goddard et al. (2014). Or, as proposed here, this discussion could be pushed even deeper into evolutionary history, broadening the spirit and reach of an archaeology of cognition.

Indeed, in this chapter my aim has been to elucidate the neuro/mental changes that undergird and explain the behavior of evolutionary creatures writ large. This project translates as tinkering with the ontology and epistemology of NSM for purposes of comprehending the history and behavioral consequences of consciousness on planet earth. From a theoretical and philosophical standpoint, using my proposed expansion of NSM encompasses a central concern of evolutionary biology (i.e., the evolution of neuro/mental phenomena) and parallels the proposal for physical science articulated by Ball (2018).

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12

EXPLORING THE PSYCHOLOGICAL BASIS FOR TRANSITIONS IN THE ARCHAEOLOGICAL RECORD

Liane Gabora and Cameron M. Smith

Introduction

No other species remotely approaches the human capacity for the cultural evolution of novelty that is accumulative, adaptive, and open-ended (i.e., with no a priori limit on the size or scope of possibilities). By “culture” we mean extrasomatic adaptations – including behavior and technology – that are socially rather than sexually transmitted. This chapter synthesizes research from anthropology, psychology, archaeology, and agent-based modeling into a speculative yet coherent account of two fundamental cognitive transitions underlying human cultural evolution that is consistent with contemporary psychology. While the chapter overlaps with a more technical paper on this topic (Gabora & Smith, 2018), it incorporates new research and elaborates a genetic component to our overall argument. The ideas in this chapter grew out of a non-Darwinian framework for cultural evolution, referred to as the *Self-Other Reorganization (SOR)* theory of cultural evolution (Gabora, 2013, 2019; Smith, 2013), which was inspired by research on the origin and earliest stage in the evolution of life (Cornish-Bowden & Cárdenas, 2017; Goldenfeld, Biancalani, & Jafarpour, 2017; Vetsigian, Woese, & Goldenfeld, 2006; Woese, 2002). SOR bridges psychological research on fundamental aspects of our human nature such as creativity and our proclivity to reflect on ideas from different perspectives, with the literature on evolutionary approaches to cultural evolution that aspire to synthesize the behavioral sciences, much as has been done for the biological sciences. The current chapter is complementary to this effort, but less abstract; it attempts to ground the theory of cultural evolution in terms of cognitive transitions as suggested by archaeological evidence.

By “archaeological evidence” we mean the material correlates or “precipitates” of behavior. While artifacts were once treated as indicators of “progress,” more contemporary approaches seek to reveal the cognitive conditions responsible for artifacts and other material precipitates of behavior (Haidle, 2009; Wragg-Sykes, 2015). Note that although our theoretical approach is founded on evolutionary principles, it is not what is often referred to as “evolutionary psychology” (Cosmides & Tooby, 1992; Sell et al., 2009), which focuses on biological underpinnings of cultural evolution, as opposed to the impact of culture as an evolutionary process unto itself. Our approach is more aligned to other evolutionary approaches to the general question of how modern cognition arose, such as those of Wynn and Coolidge (e.g., Wynn, Overmann, Coolidge, & Janulis, 2017) highlighting developmental psychology, and Bruner (e.g., 2010) highlighting palaeoneurology.

Our use of the term “transition” in the title is intentional (for as Straus, 2009, observes the term “transition” is sometimes used too casually). We begin the chapter with a discussion of the concept of evolutionary transition, for the “unpacking” of this term could be of explanatory value with respect to archaeological change and its cognitive underpinnings.

Evolutionary transitions

Transitions are common in evolution (Szathmari & Smith, 1995). Nonlinear interactions between different information levels (e.g., genotype, phenotype, environment, and even developmental characteristics) often give rise to emergent outcomes that generate discontinuities (Galis & Metz, 2007). Research into the mechanisms underlying evolutionary transitions have made headway into explaining the origins of new varieties of information organization and unpacking terms such as “adaptation due to natural selection,” aiming “to analyze trends of increasing complexity” (Griesmer, 2000). Szathmari and Maynard-Smith’s account of the eight major transitions in the history of life remains widely accepted (Szathmari, 2015; Calcott & Sterelny, 2011), with other transitions continuing to be identified, including the evolution of new sexes (Parker, 2004), and new varieties of ant agriculture (Schultz & Brady, 2008), animal individuality (Godfrey-Smith, 2011), metabolism and cell structure (DeLong, Okie, Moses, Silby, & Brown, 2010), technology (Geels, 2002), and hominin socialization (Foley & Gamble, 2009).

Research on the dynamics (e.g., rates and types) of evolutionary transitions shows that despite their diversity they exhibit common features: They (1) are rare, (2) involve new levels of organization of information, (3) followed by diversification, and (4) are incomplete (Wilson, 2010). Szathmari and Maynard-Smith include the transition from “primate societies to human societies” as part of their “Extended Evolutionary Synthesis,” but this synthesis was formulated prior to the rise of explicitly evolutionary approaches to modern cognition.

We suggest that the theory of evolutionary transitions can provide a useful framework for understanding the cognitive changes culminating in behavioral modernity (BM). In cognitive evolution, evidence of significant change might be stretched

out over time and space for many reasons, such as lag between initial appearance and demic diffusion, ambiguities in the archaeological and fossil records, etc. In this chapter we explore two such transitions. The first is the origin of a richer, post-*Pan*, post-Australopithecine culture as early as 2.2 million years ago (Harmand et al., 2015). The second is the explosion of creative culture in the Middle/Upper Palaeolithic.

Origin of post-*Pan*, post-Australopithecine culture: a first cognitive transition

Archaeological and anthropological evidence

The minds of *Australopithecus* and earliest *Homo* appear to have been anchored to the present moment of concrete sensory perceptions, i.e., the “here and now.” Simple stone (and some bone and antler) implements indicate that they encoded perceptions of events in memory, thereby supplying “timely information to the organism’s decision-making systems” (Klein, Cosmides, Tooby, & Chance, 2002, p. 306) – but had little voluntary access to memories without external cues. The upshot was minimal innovation and artifact variation.

This is evident in the early archaeological record, beginning with stone tools from Lomekwi 3 West Turkana, Kenya, 3.3 million years ago (Harmand et al., 2015), and characterized by opportunism in highly restricted environments (Braun et al., 2008). Tools were technologically on par with those of modern chimpanzees (Byrne & Russon, 1998; Blackwell & d’Errico, 2001; see Read, 2008, and Fuentes, 2015, for cognitive considerations of chimpanzee toolmaking). These tools lack evidence of symbolism (d’Errico et al., 2003), and were transported relatively short distances across landscapes (Potts, 2012). While nut-cracking and other simple tool use outside *Homo* may involve sequential chaining of actions (and thus sequential chaining of the mental representations underlying these actions), outside *Homo*, sequential processing did not occur reliably enough to cross the threshold for abstract thought (see Gabora & Aerts, 2009; Gabora & Kitto, 2013; Gabora & Steel, 2017, for mathematical models of this). Thus, it appears that early *Homo* could not invent or refine complex actions, gestures, or vocalizations, and their ability to voluntarily shape, modify, or practice skills and actions was at best minimal.

Early *Homo* evolved into several forms, including *H. erectus*, dating between 2.8 and 0.3 million years ago (Villmoare et al., 2015), and there was a shift away from biology and toward culture as the primary means of adaption in this lineage, attended by significant cultural elaboration. Having expanded out from Africa as early as 2 million years ago, *Homo* constructed tools involving more production steps and more varied raw materials (Haidle, 2009), imposed symmetry on tool stone (Lepre et al., 2011), used and controlled fire (Goren-Inbar et al., 2004), crossed stretches of open water up to 20 km (Gibbons, 1998), ranged as far north as latitude 52° (Parfitt et al., 2010), revisited campsites possibly for seasons at a time, built shelters (Mania & Mania, 2005), transported tool stone over greater distances than their predecessors (Moutsou, 2014), and ranked moderately high among predators (Plummer, 2004).

While the cranial capacity of *Homo erectus* was approximately 1,000 cc – about 25% larger than that of *Homo habilis*, at least twice as large as that of living great apes, and 75% that of modern humans (Aiello, 1996) – brain volume alone cannot explain these developments. It is widely thought that these signs of a culture richer than that of *Pan* or *Australopithecus* c. 1.7 million years ago reflect a significant transition in cognitive and/or social characteristics.

Early ideas about what caused this first transition

We can take as a starting point Donald's (1991) theory of cognitive evolution, as it was a breakthrough that paved the way for much of what followed. Because the cognition of *Homo habilis* was primarily restricted to whatever episode one was currently experiencing, Donald refers to it as an "episodic mode" of cognition. He proposed that the enlarged cranial capacity brought about the onset of what he calls a "self-triggered recall and rehearsal loop," which we abbreviate STR. STR enabled hominins to voluntarily retrieve stored memories independent of environmental cues (sometimes referred to as "autocuing") and engage in "representational re-description" (a term coined by Karmiloff-Smith [1992] to refer to internally-generated modification) and the refinement of thoughts and ideas. This was a fundamentally new mode of cognitive functioning that Donald referred to as the "mimetic mind" because it could "mime" or act out past or possible future events, thereby not only temporarily escaping the present, but communicating that escape to others.

STR also enabled attention to be directed away from the outside world toward one's internal representations, paving the way for abstract thought. We use the term "abstract thought" to refer to the reprocessing of previous experiences, as in counterfactual thinking, planning, or creativity, as opposed to direct perception of the "here and now" (for a review of abstract thought, see Barsalou, 2005). Note that in much of the cultural evolution literature, abstract thought and creativity, if mentioned at all, are equated with individual learning, which is thought to mean "learning for oneself" (e.g., Henrich & Boyd, 2002; Mesoudi, Whiten, & Laland, 2006; Rogers, 1988). However, they are not the same thing; *individual learning* deals with obtaining preexisting information from the environment through nonsocial means (e.g., learning to distinguish different kinds of trees). The information does not change form just because the individual now knows it. In contrast, *abstract thought* involves the *reprocessing* of internally sourced mental contents, such that they are *in flux*, and when this results in the generation of useful or pleasing ideas, behavior, or artifacts that did not previously exist, it is said to be *creative*. Indeed, there is increasing recognition of the extent to which creative outcomes are contingent upon internally driven incremental/iterative honing or reprocessing (Basadur, 1995; Chan & Schunn, 2015; Feinstein, 2006; Gabora, 2017).

Note that Donald's explanation focuses on neither technical nor social abilities but on a cognitive change that facilitated both. STR enabled systematic evaluation and improvement of thoughts and motor skills such that they could be adapted to new situations, resulting in voluntary rehearsal and refinement of actions and artifacts. STR also broadened the scope of social activities to include re-enactive play and pantomime.

Proposed theory of cognitive underpinnings of this first transition

Leaving aside alternatives to Donald's proposal until the end of this section, we note for now that although his theory seems reasonable, it does not explain why larger brain size enabled STR. In what follows, we contextualize Donald's (1991) schema in research on the nature of associative memory. We will ground the concept of STR in a neural-level account of the mechanisms underlying cognitive flexibility and creativity (Gabora, 2010; Gabora & Ranjan, 2013).

We start by summarizing a few well-known features of associative memory. Each neuron is sensitive to a primitive stimulus attribute, or microfeature, such as lines of a particular orientation, or sounds of a particular pitch. Items in memory are *distributed* across cell assemblies of such neurons; thus each neuron participates in the encoding of many items. Memory is also *content addressable*: there is a systematic relationship between the content of an item and the neurons that encode it. Therefore, items that share microfeatures may be encoded in overlapping distributions of neurons.

While in and of itself increased brain volume cannot explain the origin of BM, we suggest that larger brains enabled a transition from coarse-grained to more fine-grained memory. The smaller the number of neurons a brain has to work with, the fewer attributes of any given memory item it can encode, and the less able it is to forge associations on the basis of shared attributes. Conversely, the evolution of finer-grained memory meant that memory items could be encoded in more detail, i.e., distributed across larger sets of cell assemblies containing more neurons. Since memory organization was content addressable, this meant more ways in which distributed representations could meaningfully overlap, and greater overlap enabled more routes by which one memory could evoke another.

This in turn made possible the onset of STR, and paved the way for the capacity to engage in recursive recall and streams of abstract thought, and a limited form of insight (Gabora, 2002, 2010; Gabora & Ranjan, 2013). As a simple example, the reason that the experience of seeing a leaf floating on a lake could potentially play a role in the invention of a raft is that both experiences involve overlap in the set of the relevant attribute "float on water," and thus overlap of activated cell assemblies.

Items in memory could now be reprocessed until they achieved a form that was acceptably consistent with existing understandings, or that enabled goals to be achieved (Gabora, 1999, 2001). This scenario provides a plausible neural-level account of Donald's (1991) proposal that abstract thought was a natural consequence of possessing a self-triggered recall and rehearsal loop, made possible by an increase in brain size.

Comparison with other theories

Mithen's (1996) model features the accumulation and overlap of different intelligence modules. Although in its details his model runs rather counter to much current thinking including our own, his thoughts on cognitive fluidity and creativity influenced the model proposed here.

Some theories attribute this transition to social factors. Foley and Gamble (2009) emphasize enhanced family bonding and the capacity for a more focused style of concentration, further enhanced by controlled use of fire by at least 400,000 years ago. Wiessner (2014) suggested that fire not only enabled the preparation of healthier food, but by providing light after dark, facilitated playful and imaginative social bonding. Others emphasize an extrication from biologically based to culturally based kinship networks (Leaf & Read, 2012; Read & van der Leeuw 2009; Read, Lane, & van der Leeuw, 2015). We believe that these social explanations are correct but that they have their origin in cognitive changes, which altered not only social interactions but interactions with other aspects of human experience as well.

Our proposal bears some resemblance to Hauser, Chomsky, and Fitch's (2002) suggestion that the capacity for recursion is what distinguishes human cognition from that of other species, Penn, Holyoak, & Povinelli's (2008) concept of relational reinterpretation, and Read's (2008) hypothesis that recursive reasoning with relational concepts made possible a conceptually based system of social relations that evolved alongside nonsocial activities such as toolmaking. However, our proposal goes further, because it grounds the onset of recursive reasoning in a specific cognitive transition. While Read suggests that recursive reasoning was made possible by larger working memory, we argue that larger working memory in and of itself is not useful; it must go hand-in-hand with – and indeed is a natural byproduct of – a finer-grained memory. As a highly simplified but illustrative example, let us suppose that the working memory of an individual with a coarse-grained memory architecture increased from being able to process only one thing at a time (e.g., a leaf) to two (e.g., a leaf and a door). This would generally be a source of confusion. However, if it held only one thing in mind at a time but encoded it in richer detail (e.g., incorporating attributes of a leaf such as “thin,” “flat,” and so forth), it could forge meaningful associations with other items based on these attributes (e.g., other thin, flat things).

Our proposal also bears some similarity to Chomsky's (2008) suggestion that this transition reflects the onset of the capacity for a “merge” operation. “Merge” is described as the forging of associations based on their global similarity, i.e., between items that are highly similar or that co-occur in space or time. In contrast, for STR the memory must be sufficiently fine-grained (i.e., items must be encoded in sufficient detail) that the associative process can operate on the basis of *specific attributes* to which specific neurons are tuned. STR can forge associations between items that are related by as few as a single attribute and do so recursively such that the output of one such operation is the input for the next, and reliably, such that encodings are modified in light of each other in the course of streams of thought (Gabora, 2002, 2013, 2017). Detailed examples, such as the invention of a fence made of skis on the basis of the attributes “tall,” “skinny,” and “sturdy” (Gabora, 2010) and the generation of the idea of a beanbag chair on the basis of the single attribute “conforms to shape” (Gabora, 2018) have been worked out. Thus, our proposal (but not “merge”) offers a causal link between brain size and cognitive ability; i.e., having more neurons means they can be tuned to a broader range of attributes and thereby form more associations on the basis of shared attributes.

Creative culture in the Middle/Upper Palaeolithic: a second cognitive transition

Archaeological and anthropological evidence

The African archaeological record indicates another significant cultural transition approximately 100,000 years ago that shows many material correlates of BM. Though there is no single definitive indicator of BM (D’Errico, Vanhaeren, & van Niekerk, 2005; Shea, 2011), it is generally thought to involve (a) a radical proliferation of tool types that better fit tools to specific tasks (McBrearty & Brooks, 2000), (b) elaborate burial sites indicating ritual (Hovers, Ilani, Bar-Yosef, & Vandermeersch, 2003) and possibly religion (Rappaport, 1999), (c) artifacts indicating personal symbolic ornamentation (d’Errico et al., 2009), (d) “cave art,” i.e., representational imagery featuring depictions of animals (Pike et al., 2012) and human beings (Nelson, 2008), (e) complex hearths and highly structured use of living spaces (Otte, 2012), (f) calorie-gathering intensification that included widespread use of aquatic resources (Erlandson, 2001), and (g) extensive use of bone and antler tools, sometimes with engraved designs. BM extended across Africa after 100,000 years ago, and was present in Sub-Himalayan Asia and Australasia over 50,000 years ago (Mulvaney & Kamminga, 1999), and Continental Europe thereafter (Mellars, 2006).

It is uncertain whether this archaeological record reflects a genuine transition resulting in BM because claims to this effect are based on the European Palaeolithic record, and largely exclude the lesser-known African record (Fisher & Ridley, 2013). Artifacts associated with a rapid transition to BM 40,000–50,000 years ago in Europe are found in the African Middle Stone Age tens of thousands of years earlier, pushing the cultural transition more closely into alignment with the transition to anatomical modernity between 200,000 and 100,000 ybp. Nevertheless, it seems clear that BM appeared in Africa between 100,000 to 50,000 years ago, and spread to Europe, resulting in displacement of the Neanderthals (Fisher & Ridley, 2013). Despite an overall lack of increase in cranial capacity, the prefrontal cortex, and more particularly the orbitofrontal region, increased significantly in size (Dunbar, 1993), in what was likely a time of major neural reorganization (Morgan, 2013). *Homo sapiens* could now effectively archive information, and adapt it to different needs and circumstances, making their cultures radically more creative, open-ended, and accumulative than that of any prior hominin (Mithen, 1998).

This transition is also commonly associated with the origins of complex language. Although the ambiguity of the archaeological evidence makes it difficult to know exactly when language began (Davidson & Noble, 1989; Christiansen & Kirby, 2003; Hauser et al., 2002), it is widely believed – based on stone tool symmetry and complexity of manufacture – that as long ago as c. 1.7 million years *Homo* used gestural and prelinguistic vocalization communication that shared some organizational similarities with those of modern humans insofar as they differed significantly from other primate communication. The evolution of grammatically and syntactically modern language is generally placed (depending

on whether one is observing it in Africa, Sub-Himalayan Asia, or Western Eurasia) after about 100,000 years ago, around the start of the Upper Palaeolithic (Bickerton, 2014; Dunbar, 1993; Tomasello, 1999).

Proposed cognitive mechanism underlying the second transition

We propose that the root cause of the cultural explosion of the Middle/Upper Palaeolithic was a fine-tuning of the biochemical mechanisms underlying the capacity to spontaneously shift between different modes of thought in response to the situation, and that this was accomplished by varying the specificity of the activated region of memory. The ability to shift between different modes is referred to as “contextual focus” (CF) because it requires the capacity to focus or defocus attention in response to contextual factors (Gabora, 2003), such as a specific goal, a particular audience, or a particular aspect of the situation, and do so continuously throughout a task. Focused attention is conducive to *analytical thought* (Agnoli, Franchin, Rubaltelli, & Corazza, 2015; Vartanian, 2009; Zabelina, 2018), wherein activation of memory is constrained enough to hone in and mentally operate on only the relevant aspects of a situation. In contrast, by diffusely activating a wide region of memory, defocused attention is conducive to *associative thought*; it enables more obscure (though potentially relevant) aspects of a situation to be considered. This greatly enhances the potential for insight, i.e., the forging of obscure but useful or relevant connections.

Note that associative thought is useful for breaking out of a rut, but would be risky without the ability to reign it back in; basic survival related tasks may be impeded if everything is reminding you of everything else. Therefore, it would take considerable time to fine-tune the mechanisms underlying the capacity to spontaneously shift between these two processing modes such that one retained the benefits of escaping local minima without running the risk of being perpetually side-tracked. The time needed to fine-tune this could potentially be the explanation for the lag between anatomical and BM.

Once the products of one mode of thought could become “ingredients” for the other, hominids could reflect on thoughts and ideas not just from different perspectives but at different levels of granularity, from basic level concepts (e.g., rabbit) up to abstract concepts (e.g., animal) and down to more detailed levels (e.g., rabbit ears), as well as conceive of their interrelationships. This kind of personal reflection was necessary for, and indeed a precursor to, the need to come up with names for these things, i.e., the development of complex languages. Thus, it is proposed that CF paved the way for not just language but the seemingly diverse collection of cognitive abilities considered diagnostic of BM.

To see how the onset of CF could result in open-ended cultural complexity, recall that associative memory has the following properties: distributed representation, coarse coding, and content addressability. Each thought may activate more or fewer cell assemblies depending on the nature of the task. Focused attention is

conductive to analytic thought because memory activation is constrained enough to zero in and operate on key defining properties. Defocused attention, by diffusely activating a broader region of memory, is conducive to associative thought; obscure (but potentially relevant) aspects of the situation come into play (Gabora, 2000, 2010). Thus, thinking of, say, the concept “sun” in an analytic mode might bring to mind only the literal sun; in an associative mode of thought it might also bring to mind other sources of heat, or other stars, or even someone with a sunny disposition.

Once our hominid ancestors could shift between these modes of thought, tasks requiring either one mode or the other, or shifting between them in a precisely orchestrated manner, they started forging worldviews: richly integrated creative internal networks of understandings about the world and their place in it. This, we claim, is what made BM possible. Thus, the notion that diffuse memory activation is conducive to associative thought while activation of a narrow receptive field is conducive to analytic thought is not only consistent with the architecture of associative memory, but suggests an underlying mechanism by which CF enabled the ability to both (1) stay task-focused and (2) deviate from the task to make new connections, as needed. In this view, language did not evolve solely to help people communicate and collaborate (thereby accelerating the pace of cultural innovation); it also helped people think ideas through for themselves and manipulate them in a deliberate, controlled manner. Language facilitated the weaving of experiences into stories, parables, and broader conceptual frameworks, thereby integrating knowledge and experience (see also Gabora & Aerts, 2009). Instead of staying squarely in the narrow regime between order and chaos, thought could now shift between orderly and chaotic, as appropriate.

Thus, we propose that the emergence of a self-organizing worldview required two transitions. The onset of STR over two million years ago allowed rehearsal and refinement of skills and made possible minor modifications of representations. The onset of CF approximately 100,000 years ago made it possible to forge larger bridges through conceptual space that paved the way for innovations specifically tailored to selective pressures. It enabled a cultural version of what Gould and Vrba (1982) call “exaptation,” wherein an existing trait is co-opted for a new function (Gabora, Scott, & Kauffman, 2013). Exaptation of representations and ideas vastly enhanced the ability to expand the technological and social spheres of life, as well as to develop individualized perspectives conducive to fulfilling complementary social roles. This increase in cognitive variation provided the raw material for enhanced cultural adaptation to selective pressures.

Comparison with other theories

Our proposal is superficially similar to (and predates – see Gabora, 2003) the suggestion that what distinguishes human cognition from that of other species is our capacity for *dual processing* (Evans, 2008; Nosek, 2007). This is the hypothesis that humans engage in (1) a primitive implicit Type 1 mode involving free association

and fast “gut responses” and (2) an explicit Type 2 mode involving deliberate analysis. However, while dual processing makes the split between older, more automatic processes and newer, more deliberate processes, CF makes the split between an older associative mode based on relationships of correlation and a newer analytic mode based on relationships of causation. We propose that although earlier hominids relied on the older association-based system, because their memories were coarser-grained, there were fewer routes for meaningful associations, so there was less associative processing of previous experiences. Therefore, items encoded in memory tended to remain in the same form as when they were originally assimilated; rather than engaging in associative or analytic processing of previously assimilated material, there was greater tendency to leave mental contents in their original form and instead focus on the present. Thus, while dual-processing theory attributes abstract, hypothetical thinking to the more recent Type 2 mode, according to our theory abstract thought is possible in either mode but differs in character in the two modes: logically constructed arguments in the analytic mode versus flights of fancy in the associative mode. Our theory is rooted in a distinction in the creativity literature between (1) associative-divergent processes said to predominate during idea generation and (2) analytic-convergent processes said to predominate during the refinement and testing of an idea (Finke, Ward, & Smith, 1992; see also Sowden, Pringle, & Gabora, 2015, for a comparison of theories of creativity; and Gabora, 2018, for the distinction between associative versus divergent thought).

Mithen (1996) proposed that BM came about through the integration of previously compartmentalized intelligence modules that were specialized for natural history, technology, socialization, and language. This integration, he says, enabled *cognitive fluidity*: the capacity to combine concepts and adapt ideas to new contexts, and thereby explore, map, and transform conceptual spaces across different knowledge systems. A related proposal emphasizes the benefit of cognitive fluidity for the capacity to make and understand analogies (Fauconnier & Turner, 2002). Our explanation is consistent with these but goes beyond them by showing how conceptual fluidity would arise naturally as a function of the capacity to, when appropriate, shift to a more associative processing mode.

There are many versions of the theory in which BM reflects the onset of complex language complete with recursive embedding of syntactic structure (Bickerton & Szathmáry, 2009; Carstairs-McCarthy, 1999), which enabled symbolic representation and abstract thought (Bickerton, 2014; Deacon, 1997), narrative myth (Donald, 1991), enhanced communication, cooperation, and group identity (Voorhees, Read, & Gabora, in press). Our proposal is consistent with the view that complex language lay at the heart of BM, but because STR followed by CF would have enabled hominids to not just recursively refine and modify thoughts but consider them from different perspectives at different hierarchical levels, it set the stage for complex language.

Since, as explained earlier, we see evidence of recursive reasoning well before BM, our framework is inconsistent with the hypothesis that the onset of recursive thought enabled mental time travel, distinctly human cognition, and BM (Corballis, 2011; see

also Suddendorf, Addis, & Corballis, 2009). Nevertheless, we suggest that the ability to shift between different modes of thought using CF would have brought on the capacity to make vastly better use of it. The proposal that BM arose due to onset of the capacity to model the contents of other minds, sometimes referred to as “theory of mind” (Tomasello, 2014), is somewhat underwritten by recursion, since the mechanism that allows for recursion is required for modeling the contents of other minds (though in this case the emphasis is on the social impact of recursion, rather than the capacity for recursion itself). Our proposal is also consistent with explanations for BM that emphasize social-ecological factors (Foley & Gamble, 2009; Whiten, 2011), but places these explanations in a broader framework by suggesting a mechanism that aided not just social skills but other skills (e.g., technological) as well. While most of these explanations are correct insofar as they go, we suggest that they do not get to the root of the matter. As Carl Woese wrote of science at large “sometimes [there is] no single best representation . . . only deeper understanding, more revealing and enveloping representations” (2004, p. 173). We propose that the second cognitive transition necessary for cumulative, adaptive, open-ended cultural evolution was the onset of CF, because once hominids could adapt their mode of thought to their situation by reflecting on mental contents through the lenses of different perspectives, at different levels of analysis, their initially fragmented mental models of their world could be integrated into more coherent representations of their world – i.e., worldviews. This facilitated not just survival skills, conceptual fluidity, and creative problem solving, but also social exchange and the emergence of complex social structures.

In short, the explanation proposed here is the only one we know of that grew out of a synthesis of archaeological and anthropological data with theories and research from both psychology and neuroscience, and it appears to underwrite explanations having specifically to do with dual processing, conceptual fluidity, language, social interaction, or theory of mind.

A tentative genetic basis for contextual focus

The hypothesis that BM arose due to the onset of CF (the capacity to shift between different modes of thought) leads to the question: What caused CF? In this section we explore a possible genetic basis for CF. First, we provide historical context by reviewing both studies that implicated genes such as FOXP2 in the origins of language and the evidence that caused this explanation to fall out of favor. Next, we review anthropological and archaeological evidence that the coming into prominence of creative and cognitive abilities (including but not limited to those that involve language) coincides with the evolutionary origins of FOXP2. Then we synthesize these literatures in a new explanation of the role of FOXP2 in language and cognition.

FOXP2, a transcription gene on chromosome 7 (Reimers-Kipping, Hevers, Pääbo, & Enard, 2011), regulates the activity of other genes involved in the development and function of the brain (Fisher & Ridley, 2013; Kovas & Polmin, 2006).

Among other functions, FOXP2 plays a role in the functioning of the motor cortex, the striatum, and the cerebellum, which controls fine motor skills (Liegeois, Morgan, Connelly, & Vargha-Khadem, 2011). There are findings of familial resemblance for specific components of linguistic competence and suggestions of a genetic basis for such competences (e.g., Kovac, Gopnik, & Palmour, 2002).

The finding that a mutation in FOXP2 was associated with language comprehension and production in a family known as the KE Family (Lai, Fisher, Hurst, Vargha-Khadem, & Monaco, 2001) led to the proposal that the gene plays a key role in language acquisition. The family was diagnosed with Specific Language Impairment (SLI), a severe deficit in language development that exists despite adequate educational opportunity and normal nonverbal intelligence (Lai et al., 2001; Morgan, 2013). Those afflicted with SLI exhibit deficits in speech comprehension as well as verbal dyspraxia – a severe difficulty controlling the movement and sequencing of orofacial muscles required for the articulation of fluent speech (Lalmansingh, Karmakar, Jin, & Nagaich, 2012). Thus FOXP2 became prematurely known as the “language gene” (Bickerton, 2014).

Evidence that FOXP2 is actively transcribed in brain areas where mirror neurons are present suggested that FOXP2 makes language possible at least partially through its effect on the capacity to imitate (Corballis, 2004). This hypothesis was strengthened by findings that mirror neurons play a key role in language development (Arbib, 2011). However, in order to imitate the language of others there must already be others using language. Therefore, it is difficult to fully account for the origin of language by positing that FOXP2 affects language by way of its effect on imitation. Moreover, this cannot explain the existence of defects associated with FOXP2 that involve neither language nor imitation. Finally, other species imitate but do not exhibit grammatical, syntactically rich language.

The recognition that FOXP2 was not the “language gene” generated sober discussion about the simplicity of single gene explanations for complex traits. Indeed, as a transcription gene, FOXP2 only has an indirect effect on neural structure or behavior (Reimers-Kipping et al., 2011). Evidence that FOXP2 affects abilities other than language, such as cognitive fluidity and even IQ (Kurt, Fisher, & Ehret, 2012; Lai et al., 2001), and plays a broad role in the modulation of neural plasticity (Fisher & Scharff, 2009) suggests that the neurological basis of FOXP2 deficits lies in the structural and functional abnormalities of cortico-striatal and cortico-cerebellar circuitries, which are important for learning, memory, and motor control, not language exclusively. The structure of language is now widely believed to have come about through ontogenetic human learning and processing mechanisms (Christiansen & Chater, 2008), with diversity of linguistic organization the rule rather than the exception, and instances of universality reflecting stable engineering solutions satisfying multiple design constraints rather than natural selection (Evans & Levinson, 2009).

Language capacity is now widely thought to be polygenic, i.e., affected by multiple genes (Chabris et al., 2012; Kovas & Polmin, 2006), and indeed, transcription genes such as FOXP2 are often pleiotropic, i.e., affecting multiple traits. It has been firmly

established that a small perturbation (such as a mutation) can percolate through a system, resulting in widespread, large-scale change, a phenomenon known as *self-organized criticality* (Bak, Tang, & Wiesenfeld, 1987), and self-organized criticality is particularly widespread in regulatory genes (Kauffman, 1993). Thus, the possibility that FOXP2 plays a role in cognition that extends beyond language is worthy of consideration.

While it is clear that FOXP2 is important to language capacity in modern human populations, a recent reexamination of the gene in a large, global sample concludes that there is “no evidence that the original two amino acid substitutions were targeted by a recent sweep limited to modern humans <200 kya . . . [and furthermore] recent natural selection in the ancestral *Homo sapiens* population cannot be attributed to the FOXP2 locus and thus *Homo sapiens*’ development of spoken language” (Atkinson et al., 2018, p. 9). However, as noted earlier, FOXP2 is only one of several genes strongly implicated in conditioning language capacity; Mozzi et al. (2016) indicate that nine other genes are found, in various states, to be involved in skills listed as language, reading, and speech, thus effecting both cognition (language and reading) and motor control (speech). Furthermore, the evolutionary history of these genes is under investigation, and promises to enrich our understanding of the evolution of the cognition responsible for language and, by extension, behavioral modernity.

Given the evidence that FOXP2 plays a role in the evolution of complex cognitive abilities including language, but that this relationship is not solely mediated through its effects on the capacity for imitation, it seems reasonable to propose that FOXP2 and/or other, associated genes or transcription factors enabled CF. Interestingly, the appearance of anatomically modern humans in the fossil record as early as 200,000 years ago coincides with accelerated FOXP2 evolution (Corballis, 2004; Lai et al., 2001). It has been proposed that the appearance of anatomically modern humans was due to amino acid substitutions that differentiate the human FOXP2 gene from that of chimpanzees (Enard et al., 2002; Zhang, Webb, & Podlaha, 2002). Despite new challenges to the evolutionary history of FOXP2 (see earlier discussion) the preponderance of evidence currently suggests that within the last 200,000 years FOXP2 underwent at least two human-specific mutations, at least one of which occurred within the last 100,000 years (Lai et al., 2001; Morgan, 2013). This chronologically aligns modifications of FOXP2 with the onset of not just anatomical modernity but also BM. Hence we propose that the Palaeolithic transition to BM reflects a mutation to FOXP2 and/or its molecular associates that facilitated fine-tuning of the capacity to spontaneously shift between associative and analytic modes (CF) depending on the situation by varying the specificity of the activated memory region.

We propose that the kickoff point for the explosion of creativity and onset of language in the Middle/Upper Palaeolithic was human-specific amino acid substitutions to FOXP2 and/or that its associates changed modifications of basal ganglia neurons that contribute to cognitive flexibility. These neurons have longer dendrite length and greater synaptic plasticity in humans compared to chimpanzees. These

changes enhanced the efficiency of neural cortico-basal ganglia circuits, enabling individuals to spontaneously adjust to what extent the details of a given item in memory contributed to the flow of thought. For example, if not just the salient or defining aspects of a particular representation are activated but also peripheral aspects, then these peripheral features could trigger remote associations, thereby increasing conceptual fluidity. Our theory is consistent with the proposal that mutations in FOXP2 and/or its associates underwrote the capacity for both the gestures and grammars associated with BM (see Vicario, 2013).

In short, we suggest that while FOXP2 is not the language gene, it or other genes may have had a broad and identifiable influence on cognition by enabling the capacity for CF. This is not incompatible with Crow's (2012) proposal that the Protocadherin11XY gene pair played a key role in establishing cerebral asymmetry and enabling complex language. However, our proposal is compatible with evidence that FOXP2 and/or related genes paved the way for not just language but other features of BM as well. By tuning the mode of thought to match the needs of the present moment, CF allowed information to be processed at different degrees of granularity, and from different perspectives. Thus, it is by way of CF that hominins became able to combine actions and words into an infinite variety of cultural outputs, and respond to changing selective pressures. Individuals could engage in convergent thought for well-defined tasks, but shift to divergent thought when they were stuck, or when they wanted to express themselves or explore aesthetic possibilities. This enabled them to connect ideas in new ways, resulting in advanced tools, elaborate burials, and different forms of creative expression, including art and jewelry.

Discussion

This chapter outlined a theory of how the uniquely human capacity for collectively generated, open-ended, adaptive cultural evolution could have come about. Although change occurred in a mosaic fashion in the *Homo* lineage over more than two million years, two significant evolutionary transitions stand out.

First, the larger brain of *H. erectus* resulted in finer grained memory with detailed representations, paving the way for rehearsal of actions, refinement of skills, and novel associations between closely related items in memory. This enabled STR, escape from episodic proximity, representational redescription, minor improvements in cultural outputs, and an (albeit initially slow) "cultural ratcheting".

The second transition occurred approximately 100,000 ybp, a period associated with the origins of art, science, and religion (Mithen, 1998). We suggest that newly evolved basal ganglia circuits enabled the onset of contextual focus: the ability to shift between convergent and divergent modes of thought, enabling hominins to process information from different perspectives and at multiple levels of detail. Hominins could now put their own spin on the ideas of others, adapting them to individual needs and tastes, leading to cumulative innovation. Thoughts, impressions, and attitudes could be modified by thinking about them in the context of each other, and

be woven into integrated “worldviews” that define whom we are in relation to the world. This allowed the capacity for self-expression, in part by creating an environment conducive to the emergence of complex language, including grammar, recursion, word inflections, and syntactical structure, as well as comprehension.

This theory is consistent with findings that FOXP2 is associated with cognitive abilities that do not involve language, and with findings that non-language creative abilities arose at approximately the same time as complex language (Chrusch & Gabora, 2014). It is also consistent with findings that despite the existence of sophisticated cognitive abilities in other species such as birds (Emery, 2016), we alone exhibit cumulative cultural evolution. Cumulative cultural evolution may involve the “recycling” of cortical maps such that cultural innovations invade evolutionarily older brain circuits and inherit some of their structural constraints (Dehaene, 2005; Lieberman, 2016).

Elsewhere we provide support for the proposed two-transition scenario obtained using an agent-based model of cultural evolution (Gabora & Smith, 2018). We note that the origins of BM are currently being rethought in light of wide dissatisfaction with an archaic “trait-list” approach to its understanding (Ames, Riel-Salvatore, & Collins, 2013), and with nonlinear models of multifaceted cultural evolutionary change (Mesoudi, 2009; McDowell, 2013). The transitions to possession of the cognitive capacities that we propose made BM possible – STR and CF – exhibit Wilson’s (2010) defining characteristics of evolutionary transitions; i.e., they are rare and incomplete (did not “throw a switch” resulting in immediate “turning on” of BM), and involved new levels of organization. The increased sociality implied by the onset of STR and CF also meets Wilson’s expectation that evolutionary transitions drive “the suppression of fitness differences within groups, causing between-group selection to become the primary evolutionary force” (Wilson, 2010, p. 135). It is our hope that the proposed theory of cognitive evolution reflects an emerging “Extended Evolutionary Synthesis” (Smith & Ruppell, 2011; Smith, Gabora, & Gardner-O’Kearny, in press; Woese, 2004). We suggest that the origins of BM be considered an evolutionary transition that culminated in new varieties of information, both within the mind and in artificial memory systems external to it, giving way to new social arrangements, and paving the way for the complex cultural systems in which we are presently immersed.

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13

THE COGNITIVE MECHANISMS DERIVING FROM THE ACHEULEAN HANDAXE THAT GAVE RISE TO SYMMETRY, FORM, AND PATTERN PERCEPTION

Derek Hodgson

Introduction

An interesting exhibition took place recently at the Nasher Sculpture Center in Dallas, Texas, entitled “First Sculptures” and curated by Tom Wynn, an anthropologist and archaeologist, and Tony Berlant, a practicing abstract artist. The associated catalogue included contributions from a contemporary sculptor, a neuroscientist specializing in visual imagery and perception, a psychologist studying face perception, and two archaeologists specializing in Acheulean lithics (Berlant & Wynn, 2018). The aim of the exhibition was to show that some Acheulean handaxes can be regarded as aesthetic objects and, therefore, are important to understanding hominin cognition at a relatively early date. Perhaps the exhibition will stand as a watershed that marks a wider acceptance among archaeologists of the possibility that Acheulean handaxes are more than just functional objects. Certainly, some of the best examples of handaxes were brought together that suggest the reality of an aesthetic sensibility on the part of the original knappers.

Setting aside the pitfalls and biases associated with displaying the exhibits in a contemporary idiom, the handaxes themselves lend support to a link with aesthetic concerns. One of the advantages of a multi-disciplinary evaluation in this context is that scholars from fields other than archaeology are able to offer novel perspectives on stone tools. This is particularly so in the case of neuroscience and perceptual psychology, which have made great strides in understanding the way visual information

is processed by the human visual system, especially in relation to the plastic arts. Applying the insights of those disciplines to Acheulean handaxes has already shown that certain perceptual and neurocognitive correlates can shed light on a much debated and perplexing phenomenon (Hodgson, 2009, 2011, 2012; Putt, Wijesekumar, Franciscus, & Spence, 2017; Stout & Chaminade, 2007; Stout, Toth, Schick, Stout & Hutchins, 2000; Stout, Toth, Schick, & Chaminade, 2008; Stout, 2008). The handaxes in the Nasher exhibition consist mostly of exceptional examples of an over-concern for shape, whereas the majority since their inception 1.8 million years ago are not so obviously inclined. Yet, from the beginning, odd examples exist that stand out from the norm in terms of shape profile (Sánchez-Yustos et al., 2017). Such “oddities” seem to become more frequent and refined especially during the early Middle Pleistocene. There may also be a more general trend toward greater refinement and symmetry in certain assemblages (Beyene et al., 2013; Beyene, Berhane, Katsuhiko, & Suwa, 2015; Gallotti, Raynala, Geraads, & Mussib, 2014; Iovita et al., 2017; White & Foulds, 2018).

The first issue that I wish to address in this chapter is whether the prodigious symmetry of later handaxes can be regarded as evidence of a fully intentional aesthetic sense or whether the phenomenon should be considered quasi-aesthetic in having some, but not all, of the features of an aesthetic disposition. In this context, “aesthetic” refers to a sensibility that goes beyond the purely functional in a way that engages behavior that has no obvious practical value. The second issue concerns how the aptitudes necessary to make refined symmetrical tools may have led to the ability to produce aesthetic behavior completely detached from stone tools. In order to explore these issues, we need to take on board a range of findings from a number of diverse disciplines including neuroscience, perceptual psychology, evolution, and cultural imperatives. However, as Wynn and Gowlett (2018, p. 28) state:

Many enigmas remain. It is far from clear, for example, why hominins decided to exploit the aesthetic potential of their tools, although developments in understanding of social cognition may provide clues.

Symmetry and trends

With a few notable exceptions (e.g., McNabb & Cole, 2015), most archaeologists are coming around to the idea that handaxes, especially the later refined examples, display evidence of an interest in form that transcends the purely functional (Gamble, Gowlett, & Dunbar, 2011; Stout, 2011; White & Foulds, 2018; Wynn, 2002; Wynn & Gowlett, 2018). Some archaeologists also subscribe to the view of a general trend in some techno-complexes from an earlier rougher phase toward greater standardization at a later stage (Stout, Apel, Commander, & Roberts, 2014, and references therein). The evidence from those accounts attests to an interest in symmetry by particular individuals in various Acheulean traditions and/or a possible temporal trend within particular lineages where standardization has been observed even if this is restricted to certain sites. In fact, throughout the Acheulean sequence a development in symmetry

can be observed from both synchronic and diachronic perspectives. Given that an interest in the symmetry of handaxes that goes beyond the functional is accepted by many archaeologists, the question arises as to what would the increased workload required for producing such an outcome entail. In order to explore this, the repetitive gestural procedures for making stone tools are relevant.

A distinct advantage in becoming skilled at a particular task is that visuospatial capacities become increasingly automated, thereby allowing cognitive abilities to be redirected toward other concerns. In most cases, the freeing of cognitive abilities leads to the surplus cognitive capacity being reinvested in producing increasingly technically crafted artifacts, thereby improving functionality. As stated by Gowlett, Gamble, and Dunbar (2012, p. 704):

It may be that, through the last 1.5 million years, large-brained humans have possessed a great deal of “spare” technological capacity, which might lend itself to good economic use only in specific circumstances.

A stage, however, is reached when improved functionality reaches a natural limit, yet the cognitive surplus continues to exist. Perhaps it is at this juncture when the more refined symmetrical handaxes began to appear.

The odd examples from the beginning of the Acheulean onward (Sánchez-Yustos, et al., 2017; Wynn & Gowlett, 2018) may represent the output of a skilled individual knapper who had managed to progressively offload a considerable amount of visuospatial/manual dexterity. In some cases this would have been picked up by other members of the group, leading to a slight improvement in general refinement (Hodgson, 2015). This is reflected in some lineages that indeed display standardization and increased symmetry over time (Beyene et al., 2013). One of the consequences of an increasing skill-base needed to produce refined bifaces is that the knapper engages in repetitive action cycles involving manual dexterity and perceptual acumen. Raised perceptual awareness becomes especially important in order to avoid injury to the hands when shaping a refined biface. When such actions become automated they also tend to become rhythmical in that a sequence of episodes leads to either flakes of the required shape or a symmetrical biface. The raised level of perceptual awareness, when coupled with rhythmical action sequences, simulates the procedures involved when an individual engages in making a pattern, even if these are fairly rudimentary.

From symmetry to patterns

The evidence for the existence of rudimentary patterns during the Acheulean is sparse but nevertheless increasing (some examples are given in Figure 13.1). However, the finding that Neanderthals were able to make repetitive patterns with a minimum age of 64,000 ybp (Hoffmann et al., 2018; Weniger & Pike, 2018) suggests that the ability has its roots in the common ancestor to *Homo sapiens sapiens* and Neanderthals, namely *Homo heidelbergensis* and *Homo erectus*. Other basic patterns made by Neanderthals have been recovered (Garci-Diez, Fraile, & Maestu, 2013;

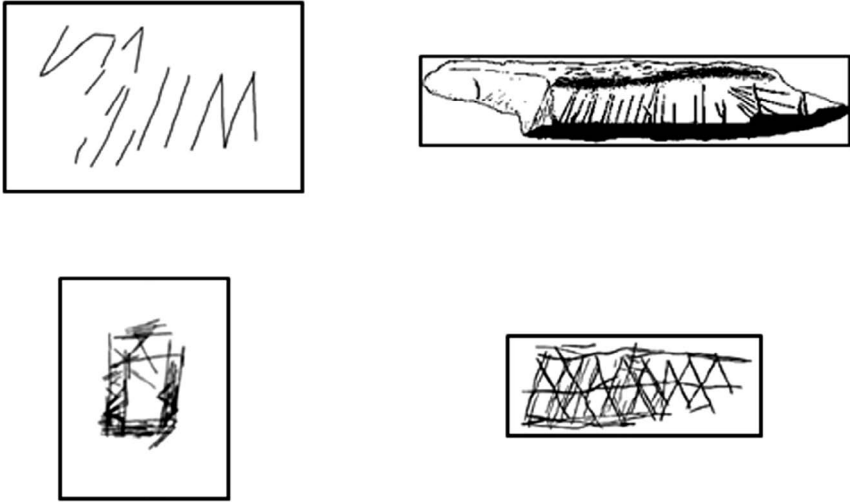


Figure 13.1 Top left to right: repetitive lines from Trinil on shell (c. 500,000 ybp) (drawing by author); Bilzingsleben on elephant tibia (c. 370,000 ybp) (Wiki Commons). Bottom left to right: Bilzingsleben on elephant tarsal joint bone (c. 370,000 ybp) (drawing by author); Blombos on ochre block (c. 75,000 ybp) (drawing by author).

Majkić, d’Errico, & Stepanchuk, 2018). This is corroborated by the Trinil shell displaying a zig-zag motif thought to date back 500,000 ybp and probably made by late *Homo erectus*. It also suggests that the Bilzingsleben repetitive marks c. 350,000 ybp may be intentional rather than accidental (Mania & Mania, 1988). In addition, evidence from Kenya found colored pigments, as well as prepared cores and points, dating to at least 320,000 ybp that may have been used for social signaling (Brooks et al., 2018). Given those findings, the possibility arises that the rhythmical action sequences employed to make Acheulean tools were transferred to the making of patterns on surfaces unconnected with actual tools. One of the important consequences of such rhythmical actions is that a signature of the manual gestures is recorded on the biface itself, either temporarily as the tool is knapped or permanently on final completion of the knapping procedure. Due to the cognitive surplus released as a knapper becomes skilled, it is likely that the accidental pattern created became apparent to the initiator. Thus, the repeated re-familiarization with a challenging procedure by ongoing elaboration serves to facilitate fluency by transforming what, at first, might be negative arousal into perceptual pleasure by reducing prediction errors (Muth & Carbon, 2013). This also arises as a result of reducing forward prediction errors (Van de Cruys & Wagemans, 2011).

In contrast to the peripersonal proto-aesthetic interest in shape of the overly symmetrical handaxes, extrapersonal aesthetic behavior is characterized by mark-making that is detached from functional constraints. For this to proceed, there needed to be a redefining of the neural tracts so that such marks could be appreciated as such. One

way of assessing the areas of the cortex responsible is by considering recent research of the brain scans of knappers. Putt et al. (2017) carried out real time scans that found specific cerebral areas became active when actors made symmetrical Acheulean bifaces, including the dorsal “where/how” (visuo-spatial manual dexterity) and ventral “what” (visual imagery/memory) pathways as well as the right orbital prefrontal cortex (related to reward feedback). The increasing confluence of those pathways has been identified as important not only for making refined symmetrical handaxes (Hodgson, 2011, 2012; Wynn, 2002) but also for the ability to produce aesthetically defined marks (Hodgson, 2006), a proclivity that may have arisen from progressively more interdigitated multi-modal neural networks. Putt et al. (2017) also make the point that piano playing engages the same networks, which underlines the co-opting of those pathways for purposes other than their original evolutionary function. Thus, neural complexity seems to give rise to surplus attentional resources that can be directed toward concerns that are not always purely practical, which become spontaneously active when engaging in behavior or endeavors that are similar to the functional precursors. One could refer to this as a kind of neural, perhaps psychological, skeuomorph or spandrel that arises as a byproduct of greater neural interconnectedness. One result of such massive interconnectivity is synesthesia (Senkowski, Schneider, Foxe, & Engel, 2008), where multi-modal neural networks undergo mutual interference.

The upshot follows that, in using and making bifaces, the rhythmical gestures involved will have led to the appearance of some accidental but orderly patterns, which is encapsulated in the following statement:

Taking these observations into account, a likely explanation for the appearance of geometrics is to be found in the fact that, in the de-fleshing of bone and making of tools, scratch marks of various kinds will have been produced. Some will have accidentally assumed the configuration of a regular pattern and therefore became significant in the way described. This is corroborated by the fact that accidentally made but regular cut marks, thought to have been made by *Homo heidelbergensis* as a consequence of systematically cutting fillets from animal carcasses, have been found on bones from Boxgrove, England.

(Hodgson, 2006, p. 63)

One of the crucial aspects of geometrical patterns is the predominance of symmetry. Due to the fact symmetry is an important means of detecting the invariant properties of the world, sensitivity to its qualities occurs rapidly and pre-consciously. Interestingly, the lateral occipital cortex – part of the fast preconscious sweep of incoming visual information – has been found to encode both symmetry and shape profile (Li & Li, 2015; Mijović et al., 2014). Moreover, together with feedback to the early visual cortex (V1 and V2), it is crucial for discriminating objects, e.g., animals, in cluttered environments (Mijović et al., 2014). In other words, it is fundamental to encoding good continuation and contour that lead to a sense of pleasure through self-induced reward as indicated by neural responses when an object is

fully identified (Palumbo, Bertamini, & Makin, 2015), which may be elicited by mu-opioids released along the ventral visual pathway (Biederman & Vessel, 2006).

As well as acting as an important preconscious cue for encoding the world, symmetry, especially reflectional (Bertamini & Makin, 2014), has an aesthetic component that may derive from the successful, self-generated reward experienced when detecting objects (Makin, Bertamini, Jones, Holmes, & Zanker, 2016). Moreover, viewing symmetry induces a smile reflex related to positive affect (Makin, Wilton, Pecchinenda, & Bertamini, 2012) and is one of the guiding principles of aesthetics (Ramachandran & Hirstein, 1999). Similarly, White and Foulds (2018) allude to the pleasure experienced in knapping symmetrical handaxes that gives rise to the release of feel-good neural stimulants. Such findings are supported by the existence of a core geometry consisting of vertical, horizontal, and oblique symmetries shared by all humans, which become salient in early infancy (Amalric et al., 2017). The existence of a proto-aesthetic dimension related to core geometry in handaxes is underlined by the fact that many conform to the golden section or golden mean (Gowlett, 1982, 2011; Pope, Russel, & Watson, 2006; Hodgson, 2008), even if the effect is fairly weak (Gowlett, 2011) (the golden section/ratio is a geometric relationship between two quantities in which the ratio of the sum of the quantities to the larger quantity is equal to the ratio of the larger quantity to the smaller one).

One other observation that reinforces the notion that handaxes were valued as aesthetic objects is the fact that some were made of impractical elephant bone and display considerable interest in symmetry (Zutovski & Barkai, 2016). As the authors state, “Some of the bone bifaces exhibit as well extraordinary aesthetic aspects” (Zutovski & Barkai, 2016, p. 9), as illustrated in Figure 13.2.

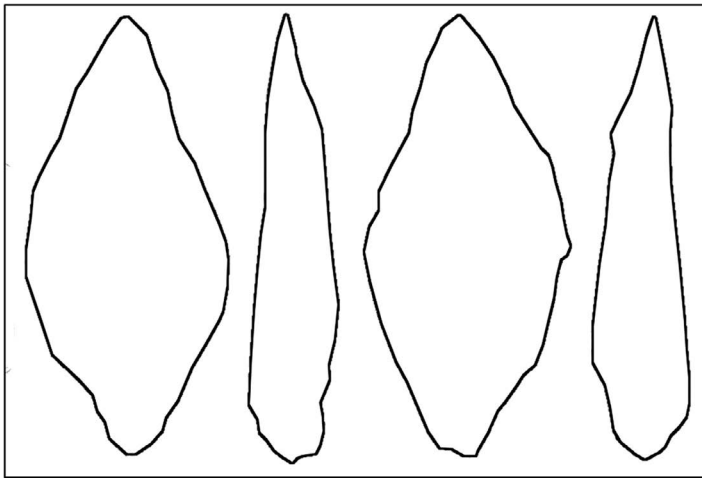


Figure 13.2 Profiled symmetry of Acheulean handaxe made of elephant bone from Fontana Ranuccio

Source: Drawing by author based on Zutovski & Barkai, 2016.

Such diverse evidence suggests that Acheulean handaxes became the preferred conduit through which a proto-aesthetic interest was expressed. This may have been because symmetry is more salient in handaxes compared to picks and cleavers, and, moreover, handaxes are more bifacially worked (Hodgson, 2011). Correspondingly, spheroids, prevalent throughout the Acheulean, also exhibit increasing refinement and symmetry over time (Lorblanchet & Bahn, 2017), which again suggests a growing concern for aesthetic criteria, especially as it remains uncertain what function spheroids served.

Neural pathways and resonance

The aforementioned considerations suggest that an early, mostly preconscious quasi-aesthetic neural response to symmetry was operative during the making of late refined symmetrical bifaces – a response that depended largely on perceptual factors related to affect underscored by resonance of the associated neural networks, as outlined in Figure 13.3 (Redies, 2015). In this figure the arrows (e.g., under “sensory perception”) indicate the perceptual resonance channel. As can be seen, this channel can become active somewhat detached from the corresponding cognitive network. However, depending on circumstances and context, the cognitive channel – represented by the small arrows in the center box – can modulate the perceptual response. Perceptual resonance has obvious and compelling parallels with the Neurovisual Resonance Theory (Hodgson, 2000a, 2006), where

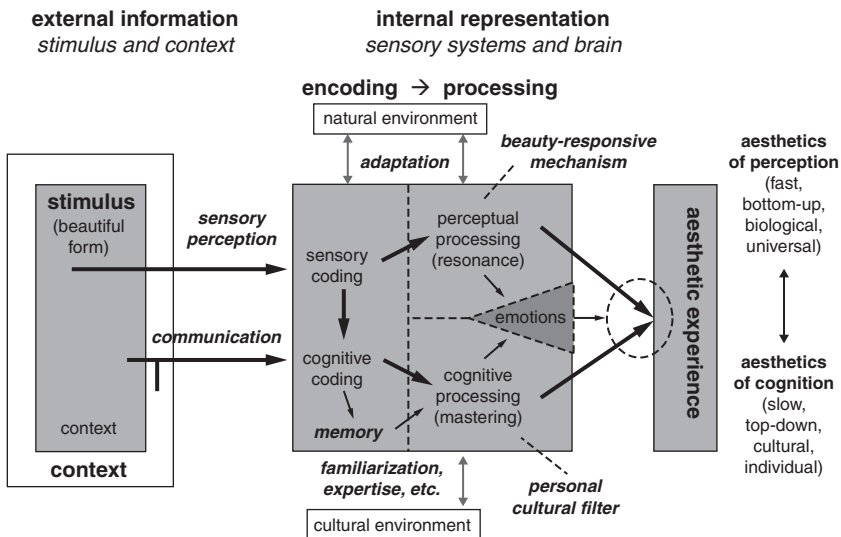


Figure 13.3 Two channels leading to an aesthetic experience

Source: Image by ©Redies, 2015. Combining universal beauty and cultural context in a unifying model of visual aesthetic experience. *Frontiers in Human Neuroscience*, 9:218. Creative Commons Attribution License (CC BY).

an affective neural response to geometry is underwritten by Gestalt systematics that are invoked when the symmetry of late Acheulean bifaces is perceived. This channel may be responsible for what has been termed “aesthetics,” which is related to biological correlates from which later, more sophisticated kinds of aesthetic behavior are derived. Figure 13.3 illustrates the more sophisticated cognitive channel (the arrows, for example, under “communication”) that allows aesthetic experience to be contextualized according to socio-cultural factors.

From the perspective of the enhanced symmetry of Acheulean handaxes, it seems that the bottom-up, more biologically conceived channel is applicable. One caveat should be mentioned regarding this model; there is massive feedback from the higher ends of both channels to the earlier neural processing centers, which, for example, allows attention to be focused on particular elements of a stimulus. This is particularly the case when one becomes skilled in a task in the way described in that the relaxation of the neural load can allow perceptual and cognitive capacities to be redirected toward other concerns. Thus, the perceptual resonance channel may have provided the springboard for the socio-cultural cognitive dispensation of aesthetics. The evidence from the archaeological record suggests that the crossover from the perceptual channel to the cognitive pathway began in earnest around 500,000 years ago with *Homo heidelbergensis* and the prevalence of refined symmetrical tools. This is underscored by the fact that cranial volume and brain size increased by around 25% (Ruff, Trinkaus, & Holliday, 1997) from 600,000 to 150,000 ybp in *Homo erectus* and *Homo heidelbergensis* (Rightmire, 2004) as well as later hominins, with the brain of *heidelbergensis* coming within range of *Homo sapiens*. Of course, this was not a unilinear trajectory but, from the beginning of the Acheulean, was more of a “random walk” (Shipton, 2018). Nevertheless, on a coarser and sometimes on a finer grained scale (Beyene et al., 2013; Beyene et al., 2015; Shipton, 2018; White & Foulds, 2018), a trend can be discerned where standardization in form proceeds from an earlier to later phase despite the myriad of intervening taphonomic factors and restrictive mechanical “least effort” criteria (Moore & Perston, 2016) and other variables that effect tool shape (Hosfield, Cole, & McNabb, 2018).

Thus, the brains of late *Homo erectus* and *Homo heidelbergensis* seem to have been pre-adapted to respond to the symmetry of handaxes more consistently than was the case for early *Homo erectus*. Wynn and Gowlett (2018) allude to the fact that the first handaxes depended mainly on ergonomic factors to do with grip, which may go some way in accounting for the relative uniformity in shape over the first million years. As a result of the growth in brain size and probable neural complexity related to more complex social interactions and foraging strategies (Gowlett, Gamble, & Dunbar, 2012), a stage must have been reached when neural networks underwent enhanced inter-correlation on many levels – including visual working memory – that benefited from interaction with diverse cognitive domains. The demands of the social brain may therefore also have led to “spare” cognitive capacity that could potentially be redirected toward other concerns (Gowlett et al., 2012).

That pre-adaptation will have formed the basis from which more complex tool morphologies derived, especially during the latter part of the Acheulean period – and

out of which the enhanced neural networks led to the non-functional aspects of material engagement from which the heightened sensitivity to geometry, needed for producing refined bifaces, was co-opted for making patterns disengaged from tools (Hodgson, 2006; Keller, 2004; Le Tensorer, 2006). In that way, the affordances associated with symmetry could generalize to other scenarios and contexts in the sense that the interest in geometry could be redirected in a way that allowed an “aesthetic” response to be expressed independently of the determining factors. This was facilitated by neural resonance whereby the excitation of the neural pathways for encoding shape induced pleasure along not only the same neural streams but also other areas of the brain.

Neural hubs, reward, proto-aesthetics, and social factors

The question arises as to the nature of the neural substrates that led to such a “detached” aesthetic response. Although increased neural interconnectedness is relevant, a more precise specification regarding the implicated brain region is needed. Certainly, the coming together of the “what” ventral and “where/how” dorsal streams is germane in that the enhanced praxis skills for the fine manipulation of tools, when fused with heightened visual attention and awareness – probably by way of the anterior supramarginal gyrus (Peeters, Rizzolatti, & Orban, 2013, see also below) – will have facilitated such an aesthetic turn. However, beyond those areas, more forward regions are relevant, namely circuits in the prefrontal cortex identified as strong candidates for multipurpose aesthetic processing.

The most important forward cortical areas recruited for aesthetic cognition include the dorsolateral frontal and medial frontal regions, which are linked to an emotional skewed reward system (Chatterjee, 2011). The orbito-frontal area is also implicated (Kawabata & Zeki, 2004) in relation to the visual channel as well as medial orbito-frontal region in the case of multi-modal aesthetic sensory processing (Ishizu & Zeki, 2011). Appositely, Putt et al. (2017) found that the right orbito-frontal cortex became active when symmetrical handaxes were produced, which corresponds to the area identified for aesthetics. The same area has been found to link aesthetic judgments with symmetry, as stated in the following:

In contrast, symmetry judgments elicited specific activations in several areas related to visuospatial analysis, including superior parietal lobule and intraparietal sulcus as well as dorsal premotor cortex . . . Interestingly, when participants judged a pattern to be beautiful (as in contrast to not beautiful), not only areas dominant in aesthetic judgments, but also one area specifically engaged in symmetry judgments (left intraparietal sulcus) showed an enhanced BOLD signal.
(Jacobsen, Schubotz, Höfel, & van Cramon, 2006, p. 282)

Jacobsen et al. (2006) concluded that the appreciation of symmetry was enhanced whenever participants found such a stimulus beautiful, a finding that mirrors the aforementioned observation that enhanced observational skills experienced in producing symmetrical handaxes can lead to the reassignment of such skills to other

domains as a result of the relaxation on cognitive load that comes with greater expertise. This seems to mark a crossover from an implicit quasi-aesthetic interest in symmetry to an explicit purposeful aesthetic engagement with the latter by recruiting the prefrontal areas of the brain where complex multisensory information is coordinated. That observation is borne out by the fact that the explicit aesthetic response to a stimulus occurs later (from 300 to 400 ms after onset) than the initial perception of the targeted stimulus, which occurs much earlier (Jacobsen & Beudt, 2017). Moreover, the neural network for aesthetic judgments in the frontal cortex partially overlaps with a corresponding network for the evaluation of social cues (Jacobsen et al., 2006; Jacobsen, 2010). Those findings provide a way of linking the ergonomic and visual-spatial protocols for producing symmetrical tools with the social aspects of signaling as expressed materially (McNabb, 2012). Moreover, the right orbito-frontal cortex (exactly the same area identified for Acheulean handaxes by Putt et al., 2017) becomes active when subjects judge abstract artworks to be emotionally engaging in a way that is linked to “goodness” (Melcher & Bacci, 2013). Again, those areas may be interconnected in the sense that the orbito-frontal cortex is associated with person perception and the inferior frontal gyrus with positive affect through connections with the limbic system in that the good and beautiful are associated for assessing empathy, reward, and social judgments. The anterior insula, which has additionally been linked to aesthetic experience, may also be involved in this network (Brown, Gao, Tisdelle, Eickhoff, & Liotti, 2011) in that it is associated with empathizing (Singer, 2006).

The exploitation of the prefrontal cortex for aesthetic purposes appears to pertain to the growing influence of the cognitive channel over the perceptual pathway, as shown in Figure 13.3. It also seems to implicate an interaction between the reward system, which searches and targets important objects in the environment, and social behavior. The reward system also reflects ease of perception and fluency that gives rise to successful recognition and which is associated with positive affect (Reber, Winkielman, & Schwarz, 1998; Reber, Schwarz, & Winkielman, 2004).

The aforementioned insights dovetail with the idea that the symmetry of later handaxes is connected to social factors, as Machin (2009) proposed. Moreover, the care knappers employed to shape handaxes, as expressed aesthetically in refined symmetry, implies social signaling in what might be referred to as assertive style that may even have extended to gift giving (Spikins, 2015). That proposition is supported by the fact that the perception of symmetry in modern humans is preferred by male and female adults as well as subadults, with female adults being more sensitive to symmetry than male counterparts (Tumler, Basell, & Coward, 2017). Pertinently, as already alluded to, White and Foulds (2018) suggest that making symmetrical handaxes is self-rewarding, which is facilitated by greater mastery in a task that causes the release of dopamine and endorphins (and mu-opioids as stipulated earlier), thereby helping to strengthen social bonds. Handaxes accordingly became a social technology that reinforced positive relations between conspecifics.

Such findings cast further doubt on the notion that symmetry was linked to sexual display/signaling (Kohn & Mithen, 1999) and bolsters the importance of an

aesthetic criterion as a way of expressing individuality through a gradually increasing assertive style (Wiessner, 1983). But how does an aesthetic interest lead to assertive (active) style? One way to address this is to recruit the notion of isochrestic style (Sackett, 1986), which is a passively conceived implicit trait of an apparent functional object. A characteristic of isochrestic style is that it tends to be conservative and, as such, may be a factor worth considering in the enduring form of Acheulean handaxes. From an isochrestic perspective, because “style” is integral to an object whether it is “functional” or not, it can signpost when significant variation occurs. It seems that before the late middle Acheulean only odd examples of handaxes displayed an over-concern for symmetry whereby the shape of most handaxes was constrained by practical considerations (Stout et al., 2014). When handaxes became more refined, and standardization and symmetry were more consistent, this may be described as the beginning of an isochrestic passive style that reflects implicit perceptual processes (as outlined in Figure 13.3) that inaugurated a bias for symmetry (Hodgson, 2006, 2009, 2012). Due to the continuing interest in geometry, which is required for creating the complex symmetry of later handaxes – including broken symmetry – this may have led (as described earlier) to the ability to respond to symmetry in other contexts, the Trinil repetitive marks being a particularly early example (see Figure 13.4 for a probable timeline). This harkens back to the naturalistic

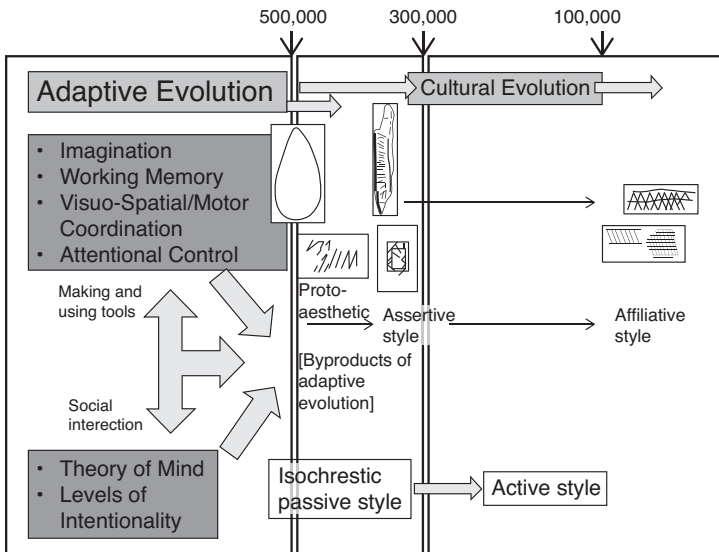


Figure 13.4 Mark-making arising from adaptive evolution relating to toolmaking skills. The left box highlights the biological adaptive precursors. The center box highlights an intermediary cross-over stage when aesthetic concerns began to be decoupled from the functionality of toolmaking that gave rise to “naturalistic aesthetics.” The right box highlights the different ways in which naturalistic aesthetics were co-opted for socio-cultural purposes

Source: Illustration by author.

resonant aesthetics from which basic geometric patterns arise that stem from the way the early visual cortex encodes information based on Gestalt principles, which also seem to drive isochrestic style. In other words, the patterns produced are not totally intentional in that they remain somewhat tethered to the implicit processes of the perceptual channel. That is, they are a reflection of the neurophysiology of the early visual system (Hodgson, 2000a) in the sense that the neurons therein are structured to respond to edges in terms of line orientation as a means of organizing visual information crucial to survival.

Discussion

McBrearty and Brooks (2000) suggested that signs of complex cognition existed in the archaeological record far earlier than previously acknowledged. In fact, just before McBrearty and Brooks' paper was published, Hodgson (2000a, 2000b) outlined a similar scenario, but, whereas McBrearty and Brooks were mainly concerned with finding evidence from tools and certain "non-functional" activities, Hodgson stressed the importance of mark-making. Indeed, Hodgson (2000a) predicted that mark-making should exist as early as 500,000 years ago. Since then, this prediction has been borne out a number of times, first in southern Africa with the repetitive motifs at Blombos, c. 77,000 ybp (Henshilwood et al., 2002; Henshilwood, d'Errico, & Watts, 2009), then in Diepkloof, c. 100,000 to 50,000 ybp (Texier et al., 2010; Texier et al., 2013), followed by the 500,000 ybp Trinil marks. In fact, and as proposed by Hodgson (2016), a recent empirical study of the Blombos and Diepkloof marks lends support to the notion that they were about pleasure invoked in peripersonal space rather than to do with signaling group norms (Tylén et al., 2018; Erard, 2018). Similar marks from a broad range of sites in southern Africa during the Middle Stone Age have also been found (for a summary, see Hodgson, 2016). Such findings provide further support to the authenticity of the Bilzingsleben marks, and the recent discovery that Neanderthals made geometric art *at least* 64,000 ybp (Hoffmann et al., 2018) adds credibility to this claim.

The fact that similar kinds of marks were made by *Homo erectus*, Neanderthals, *Homo heidelbergensis*, and anatomically modern humans suggests that the raised sensitivity to the geometry required to make Acheulean tools provided a platform from which mark-making originated. The obvious similarity of the widely distributed patterns over time, which display an over-concern for repetitive straight lines, angles, intersections, and simple recurrent motifs, suggests an outsourcing of the visuo-spatial skills and geometrics required to produce the enhanced symmetry of Acheulean handaxes – namely, repeated gestural actions and a raised awareness of form needed to produce the refined symmetries as well as to create a continuous straight cutting edge (in effect, a proxy line). The likelihood of injury to hands increases with greater refinement as more time and attention are required. Accordingly, in order to produce a symmetrical handaxe and, in some cases, both 3-D and broken symmetry (Wynn, 2002), the "what" ventral stream needed to be recruited for continuous conscious monitoring of task essentials. This required increased reciprocal interaction of

the “where/how” dorsal stream for implicit automatic manual tasks and the “what” stream for conscious monitoring (the cerebellum may also be implicated [Kochiyama et al., 2018]).

Interestingly, the ventral stream is allocentric or object-centered, meaning that an object can be comprehended from a reference frame based on the external environment in which the object is situated independent of a person’s actual location. Egocentric or viewer-centered coordinates relate more to the dorsal stream for immediate tasks associated with a person’s existing location (though there are a number of subtleties to this scenario; see Hodgson, 2018). The importance of object-centered coordinates is underlined by the fact that those with little or no visual experience tend to depend on egocentric frames of reference, whereas those benefitting from explicit visual experience rely more on allocentric imperatives (Pasqualotto, Spiller, Jansari, & Proulx, 2013), a finding supported by the fact that visual experience affects brain areas for the multisensory integration of visuo-spatial information (Postma, Zuidhoek, Noordzij, & Kappers, 2008). This suggests that vision has a direct effect on the haptic processing of spatial information in that it delivers an allocentric frame of reference thereby allowing haptic information to be encoded and directed with greater effect, an observation that is underlined by the fact that the ventral stream (also known as “vision for perception”) is characterized by the following traits:

Explicit/Conscious
Slow
Longest
Latency (Memory)
Offline
Identification of Objects
Object Knowledge
Bilateral
Object Constancy
Sustained
Viewpoint Independent

Such traits are obviously advantageous for producing Acheulean handaxes with refined symmetry and, moreover, are prerequisites for making basic geometric marks, the latter of which involve fine motor control and enhanced visual awareness. The assimilation of the ventral and dorsal streams in those tasks seems to occur in the anterior supramarginal gyrus (aSMG) located in the inferior parietal cortex (Peeters et al., 2009, 2013; Stout et al., 2008), as illustrated in Figure 13.5. The aSMG therefore appears to be a key derived area in humans (Orban, 2016) where information from the anterior intraparietal sulcus interfaces with the ventral pathway, which is a

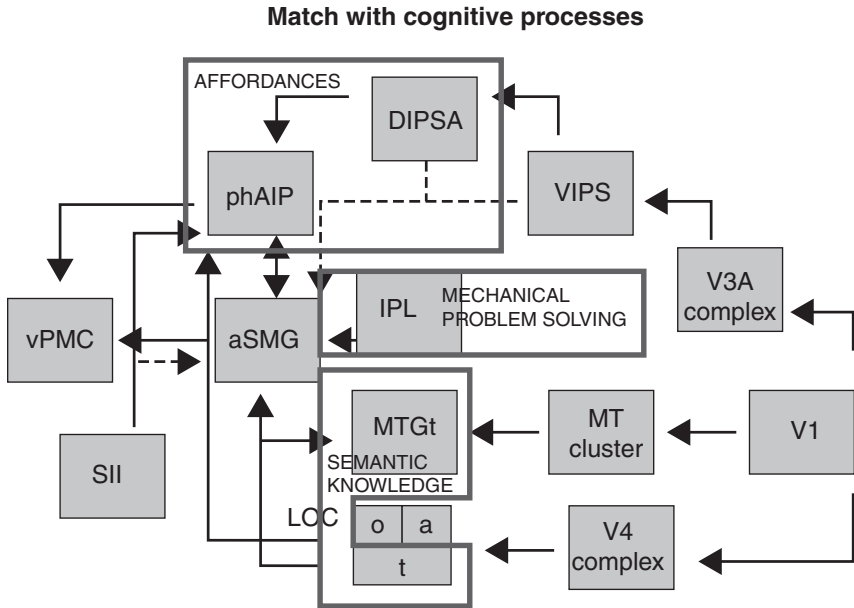


Figure 13.5 Crucial role of aSMG in assimilating ventral and dorsal streams. The relationship of the wiring diagram of phAIP and aSMG (execution) to cognitive processes is indicated by the boxes labeled “Affordances,” “Mechanical Problem Solving,” and “Semantic Knowledge.” The two lower arrows (e.g., from V1 to MT cluster and V4 complex and so forth) indicate the ventral stream, and the upper arrows (from V1 to V3A complex to VIPS and so forth) indicate the dorsal stream. The arrows on the left (e.g., from phAIP to vPMC and from aSMG to vPMC) indicate links to premotor and somatosensory areas

Source: Reproduced from Orban & Caruana, 2014, The neural basis of human tool use. *Frontiers in Psychology*, 5; Creative Commons Licence (CCBY).

Figure key: aSMG (anterior supramarginal gyrus); phAIP (anterior intraparietal); DIPSA (dorsal intraparietal sulcus anterior); IPL (intraparietal sulcus); MT cluster (V5 motion sensitive area); MTGt (middle temporal gyrus tool use); VIPS (ventral intraparietal sulcus); vPMC (ventral premotor cortex); SII (secondary somatosensory cortex); LOC o a t (lateral occipital complex and parts of LOC devoted to objects, action observation, and tools); V3A complex (for motion); V4 complex (for feature extraction).

finding supported by Putt et al. (2017) with regard to Acheulean handaxe production. Such assimilation may have been essential to produce the increasingly complex symmetries of late Acheulean bifaces and ultimately the first “detached” geometric marks that first appeared in the archaeological record 500,000 ybp.

The relative conservatism of early Acheulean tools may be related to the fact that they sufficiently met the needs required for butchering animals and perhaps a number of other associated tasks (Finkel & Barkai, 2018). It seems that may also be because humans tend to be constrained by habituated practices and dispositions (Hodder, 2006), which would have been accentuated during the Acheulean due to

the tighter coupling of the *chaîne opératoire* to brain function. During the Acheulean period hominins thereby became “tool dependent” rather than, as in nonhuman primates, “tool assisted” foragers (Bruner & Iriki, 2016).

The over-concern for the symmetry in later handaxes was probably tied to social factors related to display (McNabb, 2012) that developed as a result of increasingly interconnected neural networks, particularly within the parietal area in which the precuneus may also have played a role (Bruner & Iriki, 2016). It is to be noted that the parietal area is not only where the ventral and dorsal tracts intersect, but where the theory of mind network (Iriki, 2006) interconnects, which provides a link to the social factors of toolmaking (Gamble, 1999) in the sense that the self can henceforth be objectified through materiality in order to signal to others. During the late Acheulean individual knappers may have wished to share the sense of pleasure experienced in making symmetrical handaxes with others in the group, leading to imitation of the determining behavior. Such a reward system can be linked to the detection of objects in that, when one disambiguates a coherent shape from a confusing background, a sense of pleasure at the achievement is elicited. As symmetry is one of the major ways coherent forms are detected in cluttered environments, its refinement may have facilitated an automatic “turning on” of the sense of reassurance that occurs when symmetry is created artificially.

Conclusion

The main conclusion to be drawn from the foregoing is that making Acheulean tools initially involved a dynamic interaction between manual dexterity, cognitive functions, task demands, and the evolution of the brain. At first, bifaces remained constrained by practical imperatives related to embryonic cognitive functions. However, during the late Middle Pleistocene the increasing assimilation of neural networks led to the ability to cross-correlate information in that effects not immediately related to the task in hand began to be noticed.

Late Acheulean handaxes represent the beginning of a process where symmetry started to become detached from adaptive perceptual limitations or functional criteria. That tendency evolved as a byproduct of enduring perceptual correlates for detecting forms crucial to survival. Such a proto-aesthetic interest seems to derive from the integration of the implicit visuo-spatial dorsal pathway with the conscious ventral pathway, the latter of which deals with enhanced awareness of visual information. The increased assimilation and cross-referencing of the neural tracts of the evolving human brain should be considered as fundamental, as such interconnectivity led to greater synchrony between various cortical streams, which gave rise to a greater range of perceived affordances. The beginning of visual culture therefore appears to be deeply rooted, beginning with an interest in symmetry that eventually went beyond functionality. Taken together, those factors ultimately provided the precursors for the “outsourcing” of an enhanced awareness toward shape and form that was ultimately expressed in mark-making.

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THE ROLE OF EXPERT TECHNICAL COGNITION IN HUMAN EVOLUTION

Thomas Wynn and Frederick L. Coolidge

Introduction

Of the cognitive domains accessible to archaeological inquiry, technical cognition has produced far and away the strongest material signature. There are literally millions of stone tools filling museum drawers, many of which derive from well-dated contexts. They are the basis for a quasi-continuous record of technical activity stretching back 3.3 million years to a time when our ancestors resembled apes as much as humans, in both anatomy and behavior. Unfortunately, technical cognition continues to be underappreciated not only in cognitive science in general, but in evolutionary cognitive archaeology (ECA) and evolutionary psychology (EP). Scholars are entranced by words and language and by symbolically mediated cognition. As an example, cognitive psychological research dichotomizes memory into procedural and semantic memory, with the latter receiving the lion's share of research. Yet procedural memories are arguably far more important in the daily and hourly execution of our lives. Moreover, as we hope to show here, procedural cognition was far more important in an evolutionary sense, and far older than symbolically mediated thinking. Words and language are essential components of modern thought – no question – but they were not the whole story.

Because of its second-class status, technical cognition has generated a dearth of well-developed models. Cognitive science currently lacks a sophisticated account of how people think when executing a technical task. To be sure, cognitive scientists have occasionally turned to components of technical cognition when investigating mental phenomena, as when neuroimaging specialists have studied object manipulation (Hecht et al., 2014; Johnson-Frey, 2004; Orban & Caruana, 2014; Stout & Chaminade, 2007), when experimental cognitive psychologists have studied

social learning using copying and teaching paradigms (Morgan et al., 2015; Whiten, Horner, & de Waal, 2005), or when cognitive anthropologists have studied apprenticeship (Bloch, 2012; Hutchins, 1995; Keller & Keller, 1996; Malafouris, 2008). However, these studies have not coalesced into a coherent understanding, let alone a comprehensive model of technical cognition that generates testable implications. One could argue that this lacuna simply reflects the inherent difficulty of the target activities. Tool use and toolmaking are large-scale motor activities that are difficult to parse into components that one can test using standard psychological techniques. Yet similar difficulties afflict sport psychology, which is a well-established specialty. We suspect that the dearth reflects the low esteem that Western scholars hold for manual labor, which is a consequence of the history of Western intellectualism, not the nature of technical thinking. Studying the cognitive basis of quantum physics or narrative prose carries more inherent prestige than studying the cognition of plumbers.

In the absence of a dedicated model, our first task is thus to present a working model of technical cognition that is amenable to archaeological application. Our solution has been a model that blends elements of an anthropological study of craft production with the well-established psychological model of expert performance (Coolidge & Wynn, 2009; Wynn & Coolidge, 2014, 2016, 2017, 2004; Wynn, Haidle, Lombard, & Coolidge, 2017). Anthropological models provide rich descriptions of technical activity itself without any distillation into experimentally controlled components. We focus on craft production (one individual acting with free-hand tools) because this was the norm for hominin technical cognition until the industrial revolution 250 years ago. Psychologists such as de Groot (de Groot, 1965) and Simon (Simon & Chase, 1973) introduced the notion of expert cognition to help account for the performance of high-achieving individuals in domains such as chess and musical performance. The model has proven to be appropriate to many domains, including sport and medical diagnosis, and appears to be a style of thinking used by everyone as much as an ability limited to a few high achievers. And, as it turns out, models of expert cognition match up nicely with ethnographic accounts of craft production in natural contexts.

Expert technical cognition

Anthropologists have only recently returned to a serious interest in technical performance. Nineteenth-century ethnographers routinely included comprehensive descriptions of artifacts, production sequences, and patterns of use, but such mundane activities fell out of fashion for much of the twentieth century when anthropologists turned to more social, political, and symbolic concerns. In the last 25 years, cognitive anthropologists have again embraced technical thinking as a fundamental component of human life that relies on a form of thinking that is largely nonlinguistic (Bloch, 2012; Hutchins, 1995; D. Miller, 2005). The account that we have found most useful is that of Charles and Janet Keller (Keller & Keller, 1996), who studied blacksmithing.

The Kellers based their account of technical thinking on participant observation and interviews with artist-blacksmiths. They grounded the analysis in practice theory and the phenomenology of Alfred Schutz (Schutz, 1970). Phenomenology, especially the work of Merleau-Ponty, was an important factor in the development of embodied and extended models of mind (Malafouris, 2013). Thus, the Kellers' approach did not embrace the narrowly Cartesian understanding of mind that characterized much of contemporary cognitive science, but instead emphasized the importance of bodies, tools, and materials to the process of thinking itself. They focused on the individual actor, working in a familiar well-defined space, on a goal-directed task, i.e., the core activity of technical performance.

How does a blacksmith think? The Kellers describe two kinds of cognition – the smith's "stock of knowledge," which is essentially semantic/declarative knowledge, and a more practical set of procedural knowledge that includes "umbrella plans," "constellations of action," and "recipes." A stock of knowledge is the "sedimentation of previous experiencing acts together with their generalizations, formalizations, and idealizations" (Schutz, 1970, p. 146). These generalizations, formalizations, and idealizations constitute a folk theory of blacksmithing (the Kellers use the term "orienting principles"). Some of this knowledge is semantic in nature, and a smith uses this semantic knowledge to communicate with other smiths, and also during master/apprentice pedagogy. But far more of this folk theory consists of nonlinguistic "declarative" (fact-based) information that a smith acquires through experience and practice. This knowledge includes the inherent nature of different raw materials, how they change when heated, and the ergonomic range and feel of their tools. The smith stores this information in long-term memory in the form of visual, aural, and even olfactory imagery. Experience and practice add to this corpus of knowledge in the form of generalizations about the craft and episodic memories of specific events. But because this knowledge is largely non-semantic, one cannot learn it easily from texts. Instead, it accumulates inexorably over the course of observation of others, and through interaction with tools and materials.

The smith's stock of knowledge also consists of motor procedures acquired through practice and repetition. Like motor procedures in sport, this information is difficult to access and amend in conscious thought. One cannot think one's way to successful craft performance any more than one can think one's way to becoming a scratch golfer. There is more to this than motor memory. There are also bits of knowledge about color, sound, patterns, feel, and other contextual cues that elicit specific motor sequences, but which are not declarative, and do not even enter conscious awareness. Arguably, the majority of task-relevant information consists of this kind of nonverbal, procedural information. This explains the virtual necessity of apprenticeship – formal or not – during which novices first observe the essential components, and then generate their own body of procedural knowledge through practice and repetition.

Finally, there is a third body of information that is extra-corporeal – tools and materials. Inherent in a tool is its ergonomic potential, something Gibsonian ecological psychologists refer to as "affordance" (Gibson, 1986). A tool itself also triggers

episodic memories of past projects, successes, and failures. Similarly, the materials to be transformed have affordances that constrain the possible solutions, and channel the smith toward a narrower range of possibilities. Moreover, as the Kellers emphasize, the layout of the shop – the work space – is an active component of the smith's thinking. What is within easy reach? What is lacking and must be acquired or made? All of this knowledge – folk theory, procedural memories, and tools/materials – exists, in a sense, prior to technical activity itself. These resources are what the smith brings to the task. These are also the resources that structure the activity itself.

Technical cognition is perhaps most distinctive during the actual execution of a task. The Kellers introduce the term “constellation of action” to encompass the features of task execution. “Constellation” refers to the grouped and interconnected nature of multiple elements, and “action” indicates that many of the elements are not “in the head,” but are also in the hand and in the shop. A constellation of action is task oriented:

features of a task orient a blacksmith to selectively access both the mental reservoir provided by his stock of knowledge and the pool of material resources provided by his tool inventory and store of metal.

(Keller & Keller, 1996, p. 89; emphasis ours)

A master craftsperson's stock of knowledge is huge, and only a fraction of it is relevant to a particular task-at-hand. Thus, selective access is key to a smith's thinking and, as we will see, the key to understanding this kind of cognition. Some of what a smith knows consists of well-learned links between perceived goals in a task and the procedures than can achieve them. Psychologists use the term “cue” for such links. The Kellers' “selective access” occurs via perceptual cues.

Expertise

Over half a century ago de Groot introduced the notion of expert cognition in his study of chess masters, and cognitive psychology has had a continued interest in the thinking style of experts ever since (de Groot, 1965; Gobet, 1998; Simon & Chase, 1973). Though chess remains the gold-standard example of expert performance – largely because of its formal ranking system that identifies masters and grandmasters – psychologists have also applied the model to a broader range of activities, including musical performance, medical diagnosis, and sport (Furley & Wood, 2016; Gobet, 2016). Experts exhibit a number of salient abilities:

- 1 They assess problems very rapidly.
- 2 They demonstrate almost error free performance.
- 3 They respond rapidly to changing conditions.
- 4 They can be distracted and return to a task without loss of information.
- 5 Their abilities apply to a narrow domain and do not generalize.
- 6 They acquire their ability through prolonged, dedicated practice, typically taking years and thousands of repetitions to achieve mastery.

Even a superficial consideration of this list reveals components of attention, short-term memory, and long-term memory. Criterion #4, for example, indicates that expertise is not a short-term attentional phenomenon; distraction invariably degrades short-term memory. Yet criterion #1 is clearly a short-term, working memory ability. Thus, an expert's ability is clearly a product of both attentional and long-term memory resources. Gobet (2016) parses expertise into several overlapping domains of cognition – perception, memory (short-term, long-term, and working memory), problem solving, decision-making, and intuition. It is thus a multifaceted cognitive performance that draws on a variety of neural resources. Very little of expertise is innate; instead, it is a style of thinking that one learns through practice. Indeed, Ericsson (K. Ericsson & Delaney, 1999; K. A. Ericsson & Kintsch, 1995; K. A. Ericsson, Patel, & Kintsch, 2000) has made the controversial claim that expertise is entirely learned, and that anyone who applies the appropriate dedicated practice can achieve mastery in any expert domain. Few authorities agree, but his claim underlines how important learning is (and was) to expertise.

Technical expertise most resembles expertise in sport. Both require rapid (virtually instantaneous in sport) responses to changing conditions; both have a large motor component; both rely heavily on unconscious responses that are difficult to access with conscious resources; and both require extensive, deliberate physical practice. Furley and Wood (2016) emphasize the dual-processing features of sport expertise: Type 1 processing is “initiated and completed in the presence of relevant triggering mechanisms” (p. 416), whereas Type 2 processing requires effortful application of working memory – resources, especially mental simulation.

Successful sport performance often requires *Type 1* processing as time pressure does not allow for the effortful controlled *Type 2* processing. On the contrary, *Type 2* processing has the potential to disturb athletic performance.
(p. 416)

Deliberate practice in sport – and craft production – functions to transfer Type 2 processing to Type 1 processing, where execution occurs automatically. Moreover, deliberate practice serves to narrow attention during execution to task relevant variables.

Psychologists have proposed a number of models to describe the cognitive underpinnings of expert performance (Chase & Simon, 1973; K. A. Ericsson & Kintsch, 1995; Gobet, 2016; G. Miller, 1956). We find the models of Ericsson and Gobet to be the most useful, largely because they easily incorporate the expert craft production described by the Kellers. The centerpiece of Ericsson's Long-Term Working Memory model (LTWM) is the retrieval structure. This is a set of linked cues that is stored in long-term memory and activated, when needed, in working memory. In the parlance of memory research a retrieval structure is a “chunk” of information acquired over time through repetition and practice. A chunk is “a collection of elements having strong associations with one another, but weak associations with elements in other chunks” (Guida, Gobet, Tardieu, & Nicolas, 2012, p. 236). The elements of a retrieval structure consist of cues linked to much larger chunks of

information held in long-term memory (LTM). Think of a blindfolded chess game. How can a blindfolded player hold so much information in attention, when the capacity of short-term memory (STM) is only five to seven items? The blindfolded player need only remember a retrieval structure such as “King’s Indian Defense.” The label itself is a cue that activates the retrieval structure held in LTM, which in this case includes the specific positions of 32 pieces on 64 squares over the course of several moves. This is an amount of information that is too large to hold in active attention. The retrieval structure thus enables the player to access LTM as rapidly as if it were STM.

Cues are typically perceived features of scenes or problems – patterns of chess pieces, the stance taken by an opponent in tennis, or symptoms presented by a patient in the ER. Experts learn to recognize these cues through repetition and practice. While it may be possible to verbalize a cue – “flushed face,” for example – the cues themselves are typically sensations of some kind that the expert learns to perceive effortlessly without mediation of semantic content. Indeed, the speed and efficacy of expert response hinge on the automatic link between percept and response, bypassing the effortful access of semantic knowledge.

The drawback of retrieval structures is that they are difficult to acquire. One builds chunks such as retrieval structures by means of association, an evolutionarily old form of learning. Establishing and reinforcing links by association requires repetition. Gobet and Simon (Gobet & Simon, 2000) estimated that the number of chunks required to achieve mastery level in chess is about 300,000. More famously, the literature identifies 10,000 repetitions over a period of years as being typical for achieving expert level in any domain. Here we encounter a clear similarity with technical learning, where apprenticeship typically spans years, and thousands of repetitions.

In the LTWM model, flexibility results from the huge number of solution chunks that an expert holds in LTM, and which the retrieval structures access instantly. Such flexibility encompasses most expert problem solving. However, it may not adequately account for truly novel solutions, such as those characteristic of improvisational music or high-level athleticism (think of Lionel Messi in front of goal). The LTWM model also fails to adequately explain experts’ ability to acquire new information and solutions very rapidly, as when a chess master learns a new opening based on a single encounter. Gobet’s “template” model has a more robust account of both phenomena.

Gobet’s template theory is similar to Ericsson’s LTWM in that its centerpiece is also the retrieval structure. But the retrieval structure in template theory is more nuanced, and includes organizational features not found in Ericsson’s model. Gobet’s retrieval structure is not simply a large chunk of cues linked to appropriate responses. Instead, the retrieval structure consists of a discrimination network that includes resources that direct attention to appropriate perceptual features, and which allow access through a variety of perceptual routes. Thus, a variety of percepts can access the same discrimination network. Templates include mechanisms for learning. In addition to the core elements of stable information – indistinguishable from

the LTWM account – templates have metaphorical “slots” for variable information. Expert templates update such slots very rapidly in the context of changing percepts, enabling rapid and novel responses that bypass the usual limits of STM. “The key idea in template theory is that some chunks, which are used frequently in a domain, lead to the acquisition of more complex data structures, known as templates” (Gobet, 2016, p. 54).

To sum up briefly, expertise is a variety of thinking that deploys the vast resources of long-term memory with the speed of short-term/working memory. Its essence and power lie in its automaticity; responses to learned percepts are almost instantaneous. Effortful reflection is not an essential component, and indeed is a hindrance in most (but not all) circumstances. The cost of expertise falls to learning. Building chunks and cues, and templates, relies primarily on associations accrued through repetition and reinforcement – old cognitive mechanisms that are reliable but slow. Expertise requires thousands of repetitions, and typically years of deliberate practice.

Even though technical cognition has not been the focus of research into expertise, it is clear, we maintain, that technical thinking is expert thinking. All of the general features of expertise listed earlier apply to technical cognition in general, and to our specific exemplar of blacksmithing. Sport expertise is particularly apropos, given the critical roles of automaticity and focused allocation of attention.

Cognitive models such as Ericsson’s and Gobet’s not only help identify the cognitive resources underpinning expert performance, they also provide resources for asking evolutionary questions. Retrieval structures, for example, are the central feature of both models, with long-term memory, working memory, and cognitive control constituting important cognitive components. With these resources in hand, evolutionary scholars can begin to examine the appropriate evidence. One could, for example, approach expertise from the methodological stance of evolutionary psychology, and devise experimental protocols to assess which components of expertise are adaptations to technical behavior, and what specific activities selected for these adaptations in the past. Alternatively, one can take the approach advocated by evolutionary cognitive archaeology and examine the archaeological record for evidence of the evolution of expert performance, and by extension the cognitive abilities that enabled it.

Nonhuman primate tool use

Anthropoid primates had been making and using tools for millions of years prior to the advent of members of our genus, and thus the nature of anthropoid technical cognition must be the base condition for assessments of hominin technical cognition (Wynn, Hernandez-Aguilar, Marchant, & McGrew, 2011). Research in cognitive neuroscience has identified a distributed neural network that supports the object manipulation behaviors of anthropoid primates (Orban & Caruana, 2014; Orban et al., 2006), and which also supports the tool use of modern humans (Hecht et al., 2014; Hecht et al., 2013). Thus, an initial hypothesis should be that technical expertise has roots in anthropoid object manipulation.

Ethological research into anthropoid tool use supports such a hypothesis. Several species of anthropoid primates use tools in the wild, including macaques (Malaivijitnond et al., 2001), capuchins (Fragaszy et al., 2010), and, best known of all, chimpanzees, our nearest evolutionary cousins (Goodall, 1986; McGrew, 2010). As the best documented tool user, and our closest relative, chimpanzees are the best group to ask about expertise. We cannot actually ask them, of course, but we can take a more archaeological, observational approach and ask if chimpanzees rely on anything resembling a retrieval structure or template. Termite acquisition and nut cracking are the two most thoroughly described behaviors (Goodall, 1986; McGrew, 2010), and as the latter is a percussive activity akin to percussion in early hominin technology, it is the best example for us.

The most comprehensive account of nut cracking is that from Boussou, Guinea, where Matsuzawa and colleagues have run a series of natural experiments in which they provisioned a nut-cracking site with stones and observed the actions of a natural community of chimpanzees over a period that encompassed several hundred episodes of tool use (Carvalho, Cunha, Sousa, & Matsuzawa, 2008; Matsuzawa, Humle, & Sugiyama, 2011) (See Figure 14.1). Boussou chimpanzees place oil palm nuts on stone anvils and strike open the nuts with stone hammers. This bit of technical foraging is a significant component of the community's foraging, providing a small, but significant percentage of yearly calories.



Figure 14.1 Yo, a female chimpanzee, cracking Coula (*Coula edulis*) nuts at the outdoor laboratory in the forest of Boussou, Guinea.

Figure 14.1 is to be made available as a downloadable e-resource at www.routledge.com/9781138594500.

Source: Permission by Susana Carvalho & KUPRU, Japan.

Typically, an individual carries a stone hammer to an anvil, though the anvils are occasionally carried as well. The Boussou chimpanzees also use tool sets in which they stabilize a wobbly anvil with stone wedges. In this natural experiment, researchers numbered all of the stones, and were able follow their movement about the site, and even performed residue analyses to confirm the nature of usage. The description provided by Matsuzawa and colleagues resembles technical expertise in its basic organization:

- 1 Use of cues: Several details of the activity clearly document that the chimpanzees rely on perceptual cues linked to appropriate actions:
 - a Chimpanzees preferentially selected hammers made of diorite more often than chance would dictate. This raw material selectivity has been documented at other chimpanzee nut-cracking sites.
 - b Chimpanzees chose hammers based on features of size, including weight.
 - c If a hammer or anvil broke during use, chimpanzees continued to use it only if it still had an appropriate size and weight.
 - d They associated size with specific function. Anvils tended to be larger than hammers and wedges.
- 2 There is also reason to conclude that the Boussou chimpanzees rely on retrieval structures:
 - a Only rarely will a chimpanzee use a tool for more than one function.
 - b Nut cracking is a sequential activity, with discrete steps that have different functions and follow in sequence.
 - c But the sequences are not invariant. When appropriate, chimpanzees will skip steps.
 - d There are also sub-routines. If an anvil is unstable, the chimpanzee will search out stones to use as wedges, situate the wedges, and then return to nut cracking.
 - e Motor procedures vary according to features of stones that are in range for use, suggesting that material resources play an active role in the procedures.
 - f Chimpanzees learn nut cracking by deliberate practice with the materials.
- 3 However, learning resources are limited. Juvenile chimpanzees must each re-invent how to crack nuts. They do not, and cannot, copy motor procedures (Tomasello & Call, 1997; Whiten, Horner, Litchfield, & Marshall-Pescini, 2004). Instead, by observing adults they learn that stones make useful hammers and anvils, but they cannot identify the procedures. This is emulation, not imitation, and it accounts for the extended period of learning that extends to years, and the high frequency of failure for juveniles.

It is not surprising that chimpanzees deploy retrieval structures in their technical activity. The concept of retrieval structure is, after all, a methodological convenience that enables researchers to address a complex mental activity that relies on a variety

of cognitive resources. Do chimpanzees use long-term memory, working memory, and cognitive control in tool use? Almost certainly. Does it differ from that true of modern human technical retrieval structures? Again, the answer is yes, and the retrieval structure model allows us to identify how.

When compared to the technical expertise of a modern artist-blacksmith, the retrieval structures of chimpanzees are impoverished in most respects. Chimpanzees' stock of knowledge is much smaller than that of a smith. Chimpanzees know a limited number of sequential technical routines, even after years of practice, and use a small variety of tools and materials. But it is important to be careful when making such a comparison. If we were to ask about the smith's stock of knowledge about processing tropical fruit, it would be impoverished compared to that of the chimpanzee. It is more fruitful (!) to compare the length and organization of the retrieval structures themselves. Chimpanzee retrieval structures do parse a task into discrete steps, each of which consists of linked chunks of information (perceptual and motor), but compared to the constellation of action activated in a blacksmith's step, the chimpanzee step has many fewer chunks of information, both perceptual and motor. Thus, they require less information stored in long-term memory. Like the smith, the chimpanzee monitors a task using working memory, and when they encounter difficulties, such as an unstable anvil, they switch to an alternative routine, wedging, and return to the original task. Thus, a step in a chimpanzee retrieval structure is not simply a rote routine but has some flexibility. However, compared to the retrieval structures/slots typical of an expert smith, the Boussou nut-crackers' repertoire is very limited. It is almost impossible to contrast working memory capacity, given that successful completion is not really a measure of working memory capacity. Matsuzawa has even made the audacious claim, based on laboratory experimentation, that chimpanzee working memory capacity rivals that of people (Matsuzawa, 2001). The success and importance of retrieval structures, however, hinge on the rapid access to long-term memory, and especially the organization of the long-term memory in retrieval structures.

Boussou chimpanzees' sole reliance on emulation is a good indirect indication that their retrieval structures/templates are more simply organized than those of the smith. There is no motor copying component. A Boussou chimpanzee juvenile cannot watch an adult and modify their own motor procedures to match those of the adult. They must invent their own procedure by trial and error. Whatever the neural basis of this skill might be – and recent research has focused on the role of mirror neurons – it is an unconscious component of modern technical templates that is entirely missing from those of chimpanzees. To be fair, we must observe that modern technical learning is also learned primarily through physical practice. Copying provides the novice with a much better start than that experienced by a juvenile chimpanzee. The learning components of the two templates are quite different.

There is one final component of blacksmiths' expert retrieval structures that remains to be applied to Boussou – the folk theory of causation. Blacksmiths work with a theory of how heat and metal interact. They can express this theory as

semantic knowledge. There is no reason to think that the Boussou chimpanzees have anything comparable, even in pre-linguistic form. They do not, for example, apply a percussive theory in other domains (e.g., they do not fight one another with stone hammers, despite their predilection for dominance-related altercations), do not try to upgrade their products, and do not innovate. Indeed, there is no reason to think that chimpanzees think *about* their tools outside of the immediate context of use (Overmann & Wynn, in press). There appears to be an entire layer of thinking that humans use in technical expertise that chimpanzees do not demonstrate. However, it is again necessary to be cautious. This layer of thinking plays only a minor role in a modern smith's actual execution of a task-at-hand, which remains primarily a matter of expertise, not the more effortful thinking of a folk theory.

To sum up, the Boussou chimpanzees' technical cognition does have the basic features of technical expertise, but evidences less capacity in long-term memory, and perhaps in working memory as well. From the perspective of template theory, the retrieval structures are simpler than those of a modern blacksmith, with fewer templates, and fewer slots in each. Moreover, chimpanzees' sole reliance on emulation reflects a dearth of copying components in the templates. The important conclusion here is not that chimpanzee technical expertise is less powerful than that of a modern blacksmith – such a conclusion is facile and unremarkable – but that the concept of retrieval structure/template is applicable at all. This suggests that technical cognition is not a qualitatively unique acquisition of the human family, but has much deeper evolutionary roots.

Lokalalei 2C – hominin technical cognition 2.3 million years ago

Many palaeoanthropologists consider the development of stone tools – stone knapping in particular – to have been a watershed achievement in hominin evolution (N Toth & Schick, 2018), one that set early hominins on an evolutionary trajectory that was quite different from that of other apes. Other palaeoanthropologists disagree, emphasizing instead the continuities between ape technology and early hominin technology (Tennie, Premo, Braun, & McPherron, 2017; Wynn & McGrew, 1989). Experimental evidence from captive bonobos would seem to support the watershed position. Nick Toth and colleagues famously taught the bonobo Kanzi how to knap stone (N. Toth, Schick, Savage-Rumbaugh, Sevcik, & Rumbaugh, 1993). However, Kanzi never achieved the level of success apparent for even the very earliest stone tools in the archaeological record, leading Toth and colleagues to the conclusion that there was something that Kanzi did not understand, i.e., that he lacked a significant cognitive ability that opened up the possibility of a knapped stone technology. Reference to “understanding” implies declarative knowledge about stone knapping, even a theory of causality. Did the first stone knappers have a kind of folk theory of stone fracture? Toth et al. imply that they did. If so, then early stone knapping was very different from the technical cognition of the Boussou chimpanzees. We disagree with this optimistic interpretation, and instead suggest that early stone knapping differed in degree, not in kind, from that of chimpanzees. The expert cognition

of stone knappers did have features that distinguished it from that of apes, but a folk theory of stone fracture was not among them.

The oldest putative knapped stone tools are the 3.3-million-year-old artifacts from Lomekwi 3 in northwest Kenya (Harmand et al., 2015). Other early sites include Gona in Ethiopia at 2.6 million (Semaw et al., 2003), and Kanjera in southern Kenya at 2.2 million (Braun et al., 2008). Lokalalei 2C at 2.3 million provides the most comprehensive picture of early hominin technical activity because refitting of cores enabled Roche and colleagues to recognize and describe the *chaînes opératoires*, the decision chains, used by the hominin knappers (Delagnes & Roche, 2005). When refitting a core, the analyst reassembles excavated flakes into their original unified mass, a kind of 3-D jigsaw puzzle (see Figure 14.2).

Roche and colleagues were also able to identify probable sources for the stone, and the probable uses of the knapped flakes from cut marks on animal bone. The sequence of action appears to have been: (1) hominins selected knappable stone from a nearby gravel deposit; (2) carried the stone to Lokalalei; (3) knapped sharp flakes from the stone core; (4) used the sharp flakes to cut meat from animal body parts; and (5) abandoned the flakes on site after use. This general sequence of activity appears very similar to that demonstrated by the Boussou chimpanzees. There are minor differences. The transport distance was greater, and the tool modification step more elaborate, but overall the Lokalalei *chaîne opératoire* was apelike, and well within the competence of the kind of expert retrieval structures documented for the Boussou chimpanzees (an assessment made by others, e.g., Haidle, 2010).

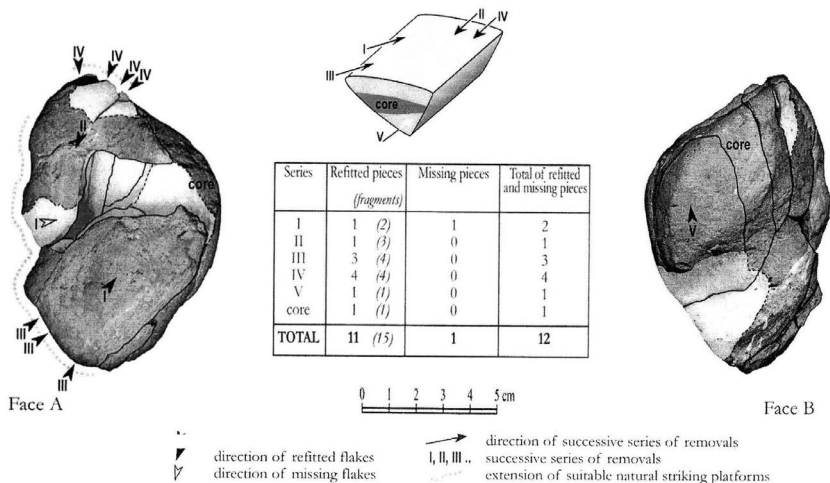


Figure 14.2 Refit core from Lokalalei 2C, a 2.3-million-year-old site in Kenya. Refitting enables reconstruction of decision sequences made by the stone knapper, an important aspect of his/her expert cognition.

Figure 14.2 is to be made available as a downloadable e-resource at www.routledge.com/9781138594500.

Source: Figure adapted by authors from: Delagnes and Roche (2005).

It is the tool modification step that may require some added abilities. Refitting has clearly established the sequence of actions and important decision points. The technical sequence began at a gravel deposit located within 50 meters of the site. The knappers selected cobbles of lava (phonolite, trachyte, basalt, rhyolite) based primarily on size and flaking quality. They occasionally broke large cobbles into smaller, more manageable pieces, but otherwise did minimal knapping at the source. After carrying the cobble or cobble fragment to Lokalei 2C itself, the hominins initiated flaking on a cobble, but if it flaked poorly (typical for the trachytes and basalts) they abandoned it after a few flake removals. On the better raw materials (usually phonolite) they initiated a sequence by first orienting the core so that they could remove flakes across the largest flat or slightly convex surface (optimal for flake propagation), and then started along the longest flakeable edge (as determined by the angle between the flat surface and the striking platform). Typically, they would knap two to five flakes from this edge, and then rotate the core to be able to remove flakes from another edge onto the same surface. On a few occasions the knappers rectified a knapping error by removing the “hinge” scar left on the flaking surface. Often the knappers would then shift to a different face of the core and remove a second series. And occasionally they shifted to a third face for a third series, after which they abandoned the core as waste (i.e., they did not use the cores as tools) (Delagnes & Roche, 2005).

From this account we can identify some of characteristics of the knappers’ retrieval structures/templates:

Evident cues

These are all perceptual cues that the knappers clearly used in the flaking procedure, and which were linked to appropriate procedural responses.

Cobble size; cobble material; flaking quality (from test knapping); flaking errors (hinges); flaking surface (flat or mildly convex); platform angle; core exhaustion

Inferred template slots

There were clearly decision points linked to alternative procedures.

Break cobble or not
Flakeable raw material or not
Abandon core or rotate
Abandon core or switch to another face

Equally revealing is the level of similarity in the reduction sequences of the several Lokalei refitted cores. They all reveal the same motor procedure: Examine core; knap flakes to failure; rotate core and reexamine; knap to failure; and so on. Either only one stone knapper did all of the knapping at Lokalei (50–60 cores), or the

knappers copied one another. The motor procedures are identical. There are actually a variety of quite distinct knapping procedures that the knappers could have reinvented on their own based on emulation, but instead they copied a single one. Thus, unlike modern chimpanzees, the Lokalelei hominins used true imitation.

In sum, the Lokalelei hominins deployed retrieval structures/templates that were modestly enhanced compared to those of the Boussou chimpanzees. They included a component of focused attention on perceptual cues, which is a function of cognitive control. These cues were linked to motor sequences, and parsed the activity into appropriate sub-routines (e.g., fracturing a core into two pieces). From the perspective of template theory there was also a learning component – imitation – not practiced by the Boussou chimpanzees. Focused attention and imitation may, of course, be sequelae of the same neural system. However, there is no reason to posit any kind of folk theory of stone knapping, or any higher, generalized layer of cognitive understanding. Like the Boussou chimpanzees, the Lokalelei hominins' technical cognition consisted of unreflective action.

Gesher Benot Ya'aqov – hominin technical cognition 780,000 years ago

At 780,000 years old, Gesher Benot Ya'aqov (GBY) was 1.5 million years more recent than Lokalelei, and much had happened in hominin evolution in the meantime, including at least a doubling in brain size. Indeed, chronologically the GBY hominins were much closer to modern humans than they were to the earliest stone knappers. But was their technical cognition equally advanced? We have chosen to examine the archaeological remains at GBY because it provides the most comprehensive picture of hominin activities of any archaeological site predating 500,000 years ago. Because of its lakeside location, the site has excellent preservation, including organic material that is rarely preserved in sites of this age. There is extensive evidence for hominin plant usage, as well as animal processing. The site also boasts the earliest generally accepted evidence for use of fire and construction of hearths (Goren-Inbar, 2011; Goren-Inbar & Sharon, 2011; Goren-Inbar, Werker, & Feibel, 2002; Herzlinger, Wynn, & Goren-Inbar, 2017).

The site has multiple occupation layers that accumulated over thousands of years of intermittent use. Because the lake-side deposits remained water-logged (shores of historic Lake Huleh in northern Israel), archaeologists were able to recover the direct remains of 55 species of edible plants. The occupants hunted fallow deer and other local fauna, and caught fish in the lake. One layer includes evidence of a hearth, surrounded by activity areas, including stone knapping. Unfortunately, refitting of cores was unsuccessful (the hominins performed some of the primary knapping off site), but archaeologists have still been able to reconstruct the *chaînes opératoires* of the stone knappers based on analysis of cores and flakes, and experimental replication. The excellent preservation actually presents other technical *chaînes opératoires* that we could use, including a very interesting procedure for gathering and processing water lily seeds that included charring. However, for comparison purposes the stone

knapping *chaînes opératoires* are more appropriate. The complete *chaîne opératoire* of GBY knapping was longer than those of Boussou and Lokalei, and also not temporally continuous. The stone knappers began at a quarry site where they knapped very large flakes off of boulder-sized cores of lava. They “roughed out” the shapes of large bifacial cutting tools at the quarry, and then carried these rough outs back to GBY, along with cores for production of smaller flakes. At a later point they “finished” the large cutting tools (by trimming them to reduce weight and produce a thinner artifact) and used them for butchery and plant processing. Instead of abandoning the tool, they retained it for future use (“curation” in archaeological parlance), eventually discarding it when the group moved on, or losing it in the course of daily life.

The knapping itself reveals important features of GBY expertise. The *chaîne opératoire* required several different retrieval structures/templates, and each retrieval structure/template included multiple discrete steps, and with each step there were multiple decision points taking the knapper in a variety of directions. For example, the stone knappers clearly traveled to the quarry with a set of specific tool varieties in mind. They then chose a knapping procedure that would remove a flake of appropriate size for the tool they intended (handaxe, cleaver, or pick). After producing the flake, they did some initial trimming to reduce weight and rough out a shape (pointed for handaxe; with a transverse bit for cleavers). The goal here was a tool, not any specific function that it would perform (Herzlinger et al., 2017; Wynn & Gowlett, 2018). They then carried the tools to GBY. Later they completed shaping the bifacial cutting tools into finished handaxes and cleavers. Sometimes they invested a great deal of effort to produce a handaxe that was beautifully proportioned and symmetrical (see Figure 14.3), but more often they simply produced a functional tool.

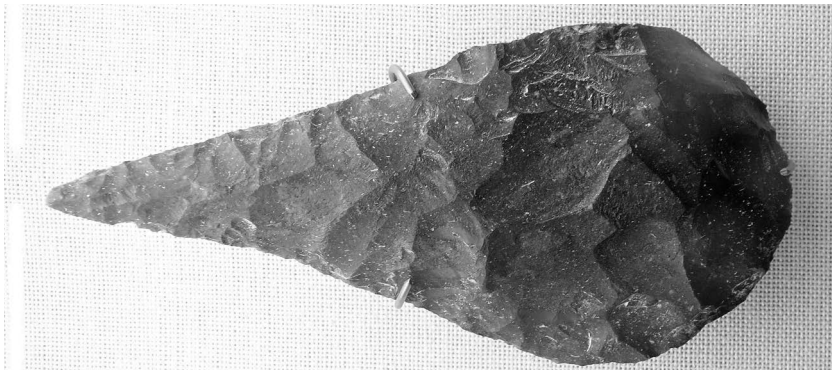


Figure 14.3 Handaxe from Geshen Benot Ya'aqov, a 790,000-year-old site in Israel. Overdetermination of form suggests that the knapper attended to social context before/during the knapping process.

Figure 14.3 is to be made available as a downloadable e-resource at www.routledge.com/9781138594500.

Source: Photo by Tom Wynn.

The “overdetermination” of the form of some handaxes suggests that hominins expected others to judge their ability (Cole, 2014; Shipton, 2010), a social component to technical expertise entirely absent from Boussou and Lokalelei.

Following the same format as that applied to the Boussou chimpanzees and the Lokalelei hominins, the retrieval structures evident in GBY lithic technology include:

Evident cues

- Perceptual:* Raw material; clast size; clast shape; clast consistency; flaking quality (from test knapping); flaking errors (hinges, etc.); flaking surface (flat or mildly convex); platform angle; core exhaustion; large flake thickness; large flake weight; large flake shape; tool edge angle; tool shape
- Memory:* Proto-typicality (group norm); tool function; social effect
- Aesthetic:* Symmetry; tear-drop shape

Template slots

- Technical:* Large flake/small flake; Kombewa/Levallois/neither; handaxe/cleaver/pick
- Functional:* Butchery; plant processing; other
- Social:* For show vs. mundane

Compared to the technical cognition of the Boussou chimpanzees or the Lokalelei hominins, GBY expertise was dramatically different. First of all, knapping *chaînes opératoires* were embedded in a much richer technical repertoire that included processing of multiple species of plants and animals, and the making and tending of fire. GBY daily life was immersed in technical procedures, and in this sense was more akin to that of modern hunters and gatherers than that of chimpanzees, or even early hominins. Second, there were many alternative procedures (and retrieval structures), each consisting of multiple cues and, from the perspective of template theory, alternative slots whose effect was a very flexible set of knapping procedures. Third, knapping retrieval structures included not just perceptual cues, but also coherent imagery of intended products (handaxes, for example), very much like the umbrella plans of a modern smith. Fourth, the GBY knappers occasionally included social considerations in finishing their tools, which played out via aesthetic cues. Fifth, GBY retrieval structures required close imitation to learn, and perhaps even apprenticeship.

In almost all respects, GBY expert retrieval structures/templates appear to have been as sophisticated as those used by a modern smith. But did the GBY hominins guide their technical expertise with a folk theory of stone knapping? A folk theory consists of semantic knowledge of causal relationships (accurate or not); at least this is the case for modern folk theories. Such a generalized understanding of relationships makes up that “higher layer” of thinking that yields great flexibility and innovation in domains of expertise. The GBY hominins present a conundrum in this regard.

Certainly, their technical expertise encompassed considerable flexibility, and their technical procedures were abundant and varied. But innovation was completely lacking. Archaeologists estimate that hominins used the lake shore at GBY off and on for as much as 50,000 years. Over this stretch there were no significant innovations in technology, or indeed in any of their expert systems. One way to understand this staggering lack of innovation is to posit a very well-developed expert cognition that operated effectively without a general folk theory of causation. There is nothing we know about the GBY hominins that suggests that they used symbols or had language (Dr. Goren-Inbar, who led the GBY excavations, disagrees with us on this point, vociferously!). To be sure, the sophistication of their expert cognition tempts one to think that linguistic instruction played a role, but a moment's reflection should discourage enthusiasm for this inference. Most modern technical learning is nonlinguistic; apprenticeship relies almost entirely on observation and practice, with minimal verbal instruction about a theory of cabinet making or blacksmithing or air conditioning. It is simply not necessary that the GBY hominins had language or indeed any kind of semantic theory of causation.

Neurological foundations for technical cognition: Lokalalei vs. Gesher Benot Ya'aqov

The overdetermination demonstrated by some GBY bifaces marks the crossing of a significant cognitive Rubicon in hominin evolution. Clearly, some of these symmetrical and beautifully proportioned handaxes required greater working memory capacity (i.e., primarily attention) than the simple production of the sharp flakes at Lokalalei. As noted earlier, some have suggested that overdetermination also indicates that there may have been a social component to technical expertise, as if some hominins expected others to judge their knapping ability (Cole, 2014; Shipton, 2010). In this respect, overdetermined handaxes may represent the first unambiguous examples of aesthetic production in the archaeological record.

Wynn and Gowlett (2018) proposed that the handaxe aesthetic began with two major components of perceptual processing: peak shift and prototypicality. Peak shift occurs when an amplified or exaggerated version of a sensory effect produces an even greater pleasurable response (e.g., the gigantism in handaxes that is seen to occur at the time of GBY). Prototypicality refers to the pleasure produced by forms that approximate the ideal exemplar of a category (e.g., Figure 14.3). With handaxes, this would have been the greater pleasure elicited as the artifact approached the symmetrical form of a hemilemniscate (i.e., a leaf-shape or half the symbol for infinity).

The neurological foundations of stone knapping involved multiple brain regions and brain networks, and current empirical evidence demonstrates that, though similar, knapping a simple flake and knapping a handaxe produce slightly different neurological activation patterns (e.g., Hecht et al., 2014; Stout, Toth, Schick, & Chaminade, 2008). The prefrontal cortices, especially the dorsolateral prefrontal cortex (dlPFC), are initially engaged in both flake and handaxe production, as the dlPFC is a major epicenter for visual working memory and decision-making. However, as

the knapping skills are mastered the dlPFC becomes less and less active over time. The frontal areas also work in close conjunction with the parietal lobes through the superior longitudinal fasciculus (which connects the frontal and parietal lobes). In the cognitively more complex handaxe knapping, there is heightened neural activity in the right pars triangularis and the left anterior supramarginal gyrus (laSMG). The laSMG becomes especially active in humans when watching others using tools and when manipulating tools themselves. The pars triangularis is relatively inactive in simple flake production.

Neglected in most contemporary empirical studies of knapping is the role of the cerebellum. The role of the cerebellum in controlling and sequencing fine motor movements has long been recognized. However, since the late 1980s, evidence has been accumulating that demonstrates the cerebellum “tweaks” thoughts just as it fine-tunes motor sequences (e.g., Ito, 1993, 2008; Leiner, Leiner, & Dow, 1989; Marek et al., 2018). In fact, the frontoparietal control network has been found to be overrepresented in the cerebellum (two-fold compared to the rest of the cortex), which is indicative of the broad range of adaptive control functions of the cerebellum. While the frontoparietal network has the primary role of attention in initiating tasks, task switching, and integrating information from other lobes and association cortices, the cerebellum appears to form abstract rules and models, and rapidly switches between competing rules and models for the completion of cognitive and motor tasks (Marek et al., 2018).

The cognitive functions of the frontoparietal network suggest the provocative possibility that handaxe production may have been linked to the evolution of language. For example, the pars triangularis in the frontal lobes is known to be involved in semantic verbal tasks, especially in the recognition of the pragmatics of words (differentiating verbs from nouns or creating appropriate verbs for particular nouns). The supramarginal gyrus has long been thought to be a neurological epicenter of inner speech and the planning and sequence of actions. The supramarginal gyrus receives information from the fusiform gyrus about the nature of objects (object recognition). Thus, it is likely that there was an initial exaptation of an ancient primate neural network for the manipulation of objects for subsequent hominin tool-making and tool use. These brain regions’ physical proximities, and their cognitive functional relatedness, make it possible that they were not inadvertently associated with each other in structure and function, but reflect their concerted evolution. The neural resources that enabled handaxe production also played a role in language, as has been proffered by Hecht (Hecht et al., 2013) and others. Hecht et al. have also hypothesized that the demands of handaxe manufacture evoked neuroplastic structural brain changes and brain network responses, in a kind of Baldwin effect that provided a mutually reinforcing engagement between handaxe production and the brain’s evolution.

Overdetermination in handaxes may also have been linked to the brain’s network for reward/pleasure and aesthetics. The brain’s reward system has its epicenter in the ventral regions of the prefrontal cortex (vPFC) with input from the basal ganglia (and other regions), and it is also intimately tied to the dopaminergic pathways

within the basal ganglia. The vPFC is, of course, physically linked to the other prefrontal cortices involved with general and emotional decision-making. The aesthetic pleasure gained from an overdetermined handaxe was presumably founded on more basic neural systems involved in attention-attraction and focused attention. It has been hypothesized that acquiring conspecifics' focused attention in order to attract appropriate mates and resources was the initial adaptation. Art and aesthetic responses, therefore, may be considered "a specialized type of attraction" (Zaidel, 2015, p. 1), and "it is reasonable to assume that the original biological animal mating intent of the display has undergone adaptive alterations now expressed as esthetic responses" (Zaidel, 2015, p. 1). These adaptive alterations, of course, may be considered exaptations, and thus, as Zaidel argued, "Beauty . . . is an emergent property in the brain of the beholder" (p. 2).

Conclusion

The archaeological record of human evolution consists almost entirely of the remains of technical activities. To make effective use of this record to document the evolution of cognition, it is first necessary to have an understanding of technical cognition. Here we have proposed a model of technical cognition based on ethnographic research (Keller & Keller, 1996) and on cognitive models of expert performance. In particular, we have drawn on Ericsson's theory of long-term working memory (K. A. Ericsson & Kintsch, 1995) and Gobet's template theory (Gobet, 1998). Both emphasize an expert's ability to access quickly large chunks of information stored in long-term memory using retrieval structures. These are well-learned and organized chunks of information – templates in Gobet's terminology – that consist of cues linked to much larger chunks stored in long-term memory. This model of thinking is not, however, limited to experts, but is a variety of thinking deployed in many domains that require fast, accurate responses to complex situations, including technology.

Applying this model to the palaeoanthropological record leads us to several substantive conclusions:

- 1 Technical expertise has evolutionary roots in anthropoid object manipulation and tool use. When the chimpanzees of Boussou use stone tools to crack open palm nuts their technical cognition exhibits features of expert performance, including reliance on retrieval structures. The capacity of these retrieval structures is significantly smaller than that of modern humans, but the organization is the same – chunks of cues held in attention that give access to information stored in long-term memory. Interestingly, there is nothing at all semantic or language-like in this variety of cognition.
- 2 The earliest stone knapping followed this ape pattern of technical expertise. The *chaînes opératoires* were similar in overall length (from material selection to discard) and divided into a similar number of coherent steps. The retrieval structures/templates had similar numbers of chunks and a similar number of

alternative procedures. These early hominins used a slightly higher number of perceptual cues in their stone knapping, but this also reflects the different methods of description. The striking similarity in the procedures used on the various refitted cores suggests that imitation was a component of technical cognition for these early stone knappers. However, there is no reason to conclude that early hominins relied on any kind of generalized knowledge or folk theory of knapping.

- 3 By 780,000 years ago technical cognition was much more human-like. The technical *chaînes opératoires* were much longer overall, and often temporally discontinuous. The hominins made tools, in addition to performing technical tasks. Their retrieval structures/templates were much larger and more elaborate than those of apes or early hominins. There were multiple technical pathways, with multiple template slots, able to respond quickly to changing circumstances and problems. Moreover, the hominins attended to memory cues and social cues during the manufacturing process, in addition to the large number of perceptual cues. Learning by imitation may not have been sufficient to acquire these retrieval structures, and guided instruction was likely. All of this resembles modern craft production and apprenticeship. However, the lack of innovation suggests that hominins still did not rely on folk theories of technology, or even theories of stone knapping.

Finally, applying this model of expertise places emphasis on nonlinguistic components of cognition and the importance of several nonlinguistic threads in human cognitive evolution. We note in particular the importance of long-term memory, the organization of long-term memory into retrieval structures/templates, and cognitive control. Language has certainly been important to recent human evolution, and may even have been prerequisite to folk theories of causality. But even as late as 780,000 years ago there is nothing about the archaeological record that required it. Thus, the first 2.5 million years of hominin technical cognition was a story of expert cognition, not language. Expert cognition was and is a tremendously successful kind of thinking that powered much of our evolutionary success, and continues to enable many of our most impressive accomplishments.

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PART III

Prehistory from the perspective of social psychology



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KEY COGNITIVE PRECONDITIONS FOR THE EVOLUTION OF LANGUAGE

Merlin Donald

The evolution of the human mind is perhaps the most complex problem that scientists have ever tried to solve, and there can be no easy, one-size-fits-all solution. There are simply too many variables to account for, each with a somewhat distinctive evolutionary rationale, to reduce to a one-dimensional theory.

Having said this, language has always stood out as the most striking feature of the human mind, and many theories of human cognitive evolution have focused largely, if not exclusively, on language evolution. In some cases, these have tried to reduce language capacity to a single novel operation, whose emergence is intended to explain not only language, but all that is unique about human cognition. A major weakness in that approach is its implicit solipsism; it places language origins in a specialized individual brain capacity, whereas, in the real world, languages are always invented by social networks, and never by isolated individuals. The developing brain assimilates language from the outside, and the genesis of language is in social networks – that is, in networks of brains, rather than in individual brains.

This shift in perspective, treating language as a primarily cultural phenomenon, ties the origins of languages and symbols to an evolved process of social-cognitive interaction, leaving open the possibility that the exquisite syntactic structure of language finds its roots in the communicative environment itself, rather than in a brain mechanism. As in the case of visual experience, linguistic complexity is generated outside the brain; it resides in culture, and the individual brain must be able to read that complexity, but not necessarily generate it. This view is compatible with the notion that the “generativity” of language is a product of the specific content that is communicated, rather than in an innate generative mechanism (Corballis, this volume). In a word, the language mechanism is bound up with culture.

Rather than trying to place the focus on evolving specialized linguistic capacities of the individual brain, as if every brain had to possess all the tools needed to invent

language, the burden is more appropriately placed on an evolving process of social interaction, and on how the public aspect of human cognition – social networks that can share mind – could have come into being. For those kinds of social networks to emerge, the biological foundations of primate cognition had to evolve along several lines that would produce a modifiable public sphere of active symbolic invention. None of these modifications would necessarily have been specialized for language itself; rather, they were more probably driven by a survival related need to create and assimilate a new form of culture that could share mind.

Much of what follows was originally written in 2016 for a special journal issue on language evolution. It outlines some of the preconditions and breakthroughs that had to emerge before such a radical transformation of human life could have taken place.

Key cognitive preconditions for the evolution of language

There is no reason to think that language evolved directly, that is, *as language*. Rather, it is the long-term interactive product of a very early (c. 3.5 million years ago) and unique shift in the direction of human cognitive evolution, marked by two important developments. The first was the emergence of a general, supra-modal capacity to rehearse and refine skills; and the second was the emergence of material culture as a major force shaping the direction of human cognitive evolution.

Evidence for the former, refined skills, appears in the archaeological record of Australopithecines. They were using stone tools to butcher game long before the genus *Homo* came into existence (McPherron et al., 2010). These early artifacts first took the form of Oldowan, and then Acheulean stone tools, both of whose manufacture is out of the reach of modern chimpanzees and gorillas (Toth, Schick, & Semaw, 2003).

These artifacts provide good evidence that there was a major change in primate motor learning capacity early in the Pleistocene epoch that enabled the deliberate modification of procedural memories. This important advance had implications that went far beyond the manufacture of stone tools. It established a key precondition for the future evolution of more sophisticated expressive systems, including languages, which require a far more powerful, but qualitatively similar, capacity to refine and rehearse skill sets. It also started, however modestly at first, a hominin process of externalizing memory, that is, using the material cultural products of skill to build a record of past achievements and knowledge that could exist external to the brain, and be carried forward for future generations.

This latter development was a key factor in driving a process whereby brain and culture could coevolve, with hominin brain design increasingly falling under the evolutionary sway of its vital relationship with an evolving range of material artifacts. Viewed retrospectively, these two changes, refined skills and a cumulative memory record external to the brain that was a product of those skills, might be regarded as a necessary pre-adaptation that enabled the later evolution of language. They opened up the possibility of building a material memory bank that could

evolve into a much more complex ecology for cognitive development. However, there is no reason to think that they were specific to language, even in truncated form; on the contrary, these early changes reflected a very basic evolutionary agenda, tied primarily to the immediate survival value of extending the physical capacities of hominins with improved material artifacts.

The presence of material culture also transformed early hominin social groups into simple distributed cognitive systems, in which skills and artifacts were distributed across groups of brains, and embedded in networks of practice that combined organic components (brains) with inorganic ones (a modifiable ecology of artifacts) in small social groups. This injected a new possibility into the adaptive equation: A brain embedded in a co-evolutionary relationship with a distributed system would be subjected to a different set of selection pressures, not only because group learning capacity would become paramount under such circumstances, but because the evolving cognitive system could also “offload” crucial epigenetic steps to the evolving distributed network. The direction of evolution could thus shift gradually away from evolving fully equipped, largely self-contained individuals, toward interactive and social capacities that would ensure the successful operation of the social network as a distributed cognitive system.

In my own work, I have developed a gradualistic co-evolutionary scenario for language based upon these kinds of early changes to the primate cognitive repertoire (Donald, 1991, 1993a, 1999, 2001, 2013).

- 1 Languages emerge from the interactions of several brains in social networks, and there is no evidence for the idea that, on its own, a single isolated human brain could generate, or even conceive of, language. Brains get their languages from elsewhere. Languages are negotiated, like treaties, in a communicative environment, by brains that are completely non-symbolic (as in “neural net” computation) in their internal operations. Following that logic, the intricate complexities of language, including even such exquisite phenomena as syntax, reflect the complexity of the challenges presented by the interactive environment that generated it. As in the case of visual experience, the complexity of language is imposed from outside.
- 2 If languages are products of cognitive interactions in groups, this fact alone would demand a culture-first theory of language genesis. The evolutionary question then becomes: How would sophisticated and cognitively demanding interactive environments (complex cultures) have evolved in the first place? In such a scenario, our focus should shift to describing what adaptations to the hominid brain would be essential for consolidating the complex forms of culture that would trigger the spontaneous combustion of such exotic things as languages.
- 3 Another, and closely related, point follows: Languages are not the only evolutionarily novel aspects of the human mind that demand a special evolutionary explanation. Archaeological evidence suggests strongly that human ancestors were skilled long before they were articulate. Of course, the truth of this

assertion depends upon our definition of language, but there is no evidence that full language capacity – defined as the ability to tell an original story based on personal experience (Nelson, 1998) – existed prior to the emergence of sapient humans, whereas rehearsed and refined skills – sufficiently complex that they required at least some pedagogical guidance for their transmission (Morgan et al., 2015) – existed millions of years earlier. Refined skill has its own very clear adaptive rationale, but it may also have set the stage, serving as a precondition for the kind of cultural evolution that could eventually produce language.

- 4 Of course, the possibility must be entertained that language came first, and was the precondition for complex culture. However, that hypothesis has a fatal flaw: Languages are complex skill-hierarchies in themselves, and must be learned. Therefore the cognitive apparatus for refining skill must have existed in some form before languages could emerge from group interactions. There is a causal chain argument at the core of this argument: Refined skill, involving the systematic practice and rehearsal of an action toward improving its outcome, is a requirement for lexical invention. Humans have a remarkable capacity for acquiring, rehearsing, and refining hundreds of skills, and arranging them in complex automatized hierarchies; language is just one example of such a hierarchy. I have argued that a general capacity for refining skill was fundamental because a capacity for refining skill is a logical precondition for the evolution of languages: Any morpho-phonology, and any lexicon, whether oral, manual, or multimodal, consists of a complex set of conventionalized and automatized skills (Donald, 1998b). Thus the evolution of a capacity for refining complex skill-hierarchies is a prior consideration in any theory of language evolution. A parsimonious theory should try to account for both features, that is, for both refined skill and language, in that order.
- 5 The convergence of refined skill and a much more complex material culture in the Lower Palaeolithic, and possibly earlier, is evidence that hominin cognitive evolution had already turned in a uniquely collective direction. The effective use of refined skills in groups entails both some degree of pedagogy and collaboration; recent work by Morgan et al. (2015) confirms this to be the case, even in anatomically modern humans attempting to improve their Oldowan toolmaking skills. Survival was increasingly linked to the individual's ability to interact effectively with some form of a networked public memory system, however primitive, exemplified perhaps by the networks of practice that still characterize cultural transmission systems for preserving skill in human populations (Hutchins, 1995). Memory for a variety of special skills usually involves some division of labor, as well as a collaborative strategy for passing those skills on to every new generation. Thus the memories that sustained a skilled society of hominins were held collectively, aided by the existence of material reminders of the ways of life of past generations.
- 6 This arrangement provided a framework for subsequent adaptations to a variety of new and different ecologies. This lifestyle was necessarily supported by conventionalized networks of practice, which by their very nature acquire significance, forming a foundation for a “mimetic” system of expression that

includes conventionalized gestures, group displays and rituals, and proto-words. This kind of culture shares much in common with cultures observed in other mammals (see, for example, Whiten, 2011), but human mimesis has the added element of less fixed stereotypy, much wider and innovative variety, and greater flexibility across expressive modalities, as well as that important link to potentially cumulative material cultural change.

- 7 Mimetic performances are somewhat similar in their semiotic function to the home signs of deaf people who lack sign language (see Goldin-Meadow & Brentari, 2015; also Donald, 2001, chapter 6). This “mimetic” form of culture marked the first truly public representations of hominin culture, characterized by an expressive mode best labeled as “embodied action-metaphor.” This mode of expression has been retained in modern human society, not only in the transmission of skill, but also in such common phenomena as public displays of grief, power, and celebration; and in the implicit expressive codes found in athletics, dance, and song, as well as some aspects of theatrical performance (Donald, 1998a, 2001, 2013).
- 8 The move to mimetic culture was an essential first step in the direction of language. It created a communicative culture that was capable of accumulating knowledge (mostly about making and using tools in its earliest stages, but also about gesture and ritual) in a distributed cognitive-cultural memory system. Since group behavior “records” and preserves the rules of even the simplest conventions, individual brains were relieved of the need to be the sole source for remembering the operations needed to reproduce any specific suite of hominin survival skills.
- 9 This development also changed the direction of brain evolution in an important way: Complex skills require a high degree of metacognitive self-supervision and social awareness. Archaeological studies of fire use in human ancestors provide even more compelling evidence that *Homo erectus* was moving in that direction over one million years ago (Berna et al., 2012; Wrangham, 2009). There is (as yet) no evidence that this level of self-supervision existed in the Australopithecines, whose toolmaking skills were more limited, and nonhuman primates do not rehearse skills at all. This provides an important comparative guidepost to what is unique in the human capacity for refining skill. Non-human primates, including presumably our Miocene common ancestor, seem to lack the kind of detailed and flexible self-representational maps needed to guide the sophisticated rehearsal and refinement of action. Even after having being taught how to break stones to create a cutting tool, bonobos do not try to improve their technique. Similarly, although gibbons may throw stones as projectiles in regional fights over territory, they never think to practice or refine their technique. The necessary metacognitive capacities are underdeveloped in these species, but were evidently highly developed in the human line (Donald, 2013), and especially evident after the emergence of *Homo erectus*. Given their ability to fashion the simpler forms of finished stone tools, Australopithecines probably fell somewhere between the Miocene primates and later hominins.
- 10 Much more systematic and extensive rehearsal is necessary to master the techniques involved in manufacturing Acheulean tools, especially those made

from the hardest, sharpest substances available, flint and obsidian. In rehearsing such finely tuned patterns of action, actors must first recall their previous attempts with some precision, and then reproduce those accurately, with modifications, while evaluating the effectiveness of each attempt to reach an idealized result.

- 11 That sequence – the review-rehearsal loop – depends upon a rudimentary form of voluntary memory retrieval. The existence of more complex stone tools such as the Acheulean handaxe is solid evidence that a change had already occurred in the brain of *Homo erectus*, enabling not only improved metacognitive self-supervision, but also more accurate recall of very specific procedural memories, along with detailed evaluation of performance outcomes. This development seems to have reached a critical point approximately 1.6 million years ago, with the appearance of the first Acheulean toolkits made from flint. Their effective use was responsible for a hominin “master toolkit” that could be used to make and refine other kinds of tools from a variety of softer materials (Donald, 1993b, 1998b).
- 12 The gradual expansion of the hominin toolkit, along with an increasing number of cultural achievements, including the mastery of fire and the cooking of food, provides evidence of an evolving capacity for the ability to rehearse and refine more complex skills by circa 500,000 years ago. The skills involved in fashioning a tool such as a handaxe or a hafted spear entail mastering a hierarchy of several interlinked and automatized sub-routines in a wider context (see Whiten, Toth, & Schick, 2009). Autocuing, or the ability to deliberately search one’s own memory, must become increasingly accurate and fast as skills become more complex. Because of its exquisite context-dependency, the capacity for autocuing procedural memories provided a platform for evolving a path to mediate recall of other kinds of memories, including those that are central to the modern human mind, such as semantic and episodic memory (Donald, 2012).
- 13 The unique vocal skills of hominins are an additional evolutionary puzzle that waits for a detailed solution. I suggested, based on a review of the neuropsychological evidence available at that time (1991), that the “review-rehearsal loop” underlying refined skills was a supra-modal adaptation from the start, engaging the entire preexisting Miocene primate voluntary motor repertoire, including whatever limited voluntary vocal capacities primates already had. Under those conditions, selection pressures favoring an expanded vocal range would have developed wherever and whenever an increased vocal range proved adaptive, opening the door to gradual “voco-mimetic” evolution in parallel with the review-rehearsal loop. This might have started quite early in the hominin scenario, as early as 3.5 million years ago, but was almost certainly underway by the time Acheulean tool culture first emerged around 1.6 million years ago. Palaeogenetic research might eventually resolve this issue.
- 14 Mimesis, including voco-mimesis, may have set the stage for the emergence of more complex communication, but other variables also needed to be in place for the emergence of speech, including high-speed voco-mimetic recall.

A vocal language of any kind demands a flexible and highly efficient system for high-speed online autocuing of selected lexical items stored in an expanded procedural memory system (see Donald, 2012).

- 15 Moreover, as will undoubtedly be spelled out in detail by other contributors to this volume, the evolution of joint intentionality, leading to the elaborate and detailed mindsharing cultures of the modern era and increasingly intricate intersubjective representational games, was an additional precondition for the final evolutionary push in the direction of full-fledged language (Tomasello, 2008). The strictest developmental criterion for full language capacity is the ability to construct an original narrative based on personal experience (Nelson, 1998). This criterion has obviously been met by anatomically modern humans; it is not yet clear whether it was met by other closely related hominins.
- 16 There will be no quick fix or easy road to a more detailed theory of language evolution. A full theory will require good evidence on exactly what changed, and when, in the hominid brain during the lead-up to the point where human ancestors were able to spontaneously generate languages. An adequate level of theoretical detail cannot be achieved without further advances in palaeogenetics, and a considerably more advanced model of the detailed functional architecture of the cerebral cortex than anything currently available.
- 17 Nevertheless, we have come a long way toward a general explanation in principle. Rather than evolving in a direct manner, or as a specialized modular system added to a primate brain, language seems to have emerged as a cultural phenomenon, after a graduated series of modifications to a set of preexisting, and basically primate, cognitive capacities that created the unique preconditions needed for the genesis of a collective, distributed, and shared system of thought and memory, which eventually led to spoken languages and other, literacy-dependent symbolic systems in the complex multi-layered mix found in modern humans.
- 18 Language is, in this sense, not a feature of the brain *per se*. It is a cognitive epiphenomenon, a socially constructed (Searle, 1969) cultural over-write imposed on a brain that is essentially primate in its design. Language thus has its origin in a distributed cognitive system, while it is performed by a local cognitive system, that is, the brain of an individual. It is the child of an interactive cultural imagination, that is, of groups of brains in collision. Its original interactive logic is primarily “mimetic” in the Aristotelian sense; that is, it follows an analogue, embodied logic, based on a greatly expanded capacity for procedural learning and mimetic expression. Purely symbolic expressive systems such as analytic and mathematical thought eventually emerged from imposed sets of culturally generated conventions and algorithms, but they were deliberate and highly interactive, and thus entailed a heavy load on conscious capacity in their invention (see Donald, 2001). But these innovations were developed only very recently, when viewed in an evolutionary context, and only emerged after long experience with artificial symbolic devices such as mathematical notations. The primary evolutionary process driving language evolution was a broadly cognitive one,

not a specifically linguistic one. It involved the simultaneous juggling of many different brain parameters (including plasticity itself) that coevolved with a host of interactive cultural parameters, under the profound influence of the rich material culture that has defined the survival strategy of genus *Homo*.

Conclusion

Archaeological evidence suggests that full language as we know it came quite late in human evolution, when hominin material culture began to show evidence of complexity and richness that suggest the existence of widely held knowledge networks. However, the refined skills of *Australopithecus afarensis* and *Homo erectus* might well have had an immediate effect on communication, yielding a gestural system resembling, perhaps, the home signs of nonsigning deaf children. As hominin social life, of necessity, came to revolve around successful tool use, as well as competent tool manufacture, complex social scenarios followed, each involving the use of tools in cooperative interactions, as in hunting, fishing, fire tending, the building of shelter, and so on. Expressive behavior presumably tracked the complexities inherent in the kind of cooperative “mimetic” cultures that emerged, as they developed. In other words, language capacity initially improved as a side story to the main event, which consisted of evolving a radically improved capacity for skill. At some later point, perhaps around a million years ago, it became the main event.

We now understand that hominin culture was not merely an outcome of underlying biological change; rather, its increasing presence in hominin life drove much of that change. A culture founded on refined skill sets requires a developmental mechanism for the transmission of vital skills and demands a pedagogical dimension (Gardenfors & Hogberg, 2017). The evolving hominin brain had to become better equipped to deal with the massive developmental uncertainty created by an innovative skill-based culture. As hominins became able to vary their skill sets in unpredictable ways, it would have posed a challenge to the developing brain. One other consequence of this uncertainty is that neural plasticity would have come under selection pressure.

Thus, at least three very basic brain properties – voluntary access to procedural memory, improved metacognitive self-supervision, and greater developmental plasticity – were prominent among the modifications that the primate brain needed to evolve, before the preconditions needed for the genesis of language and symbolic invention were in place. These, along with other cognitive adaptations related to socialization and mindsharing, were necessary for the emergence of the highly variable knowledge networks unique to modern humans. It was the emergent properties of those kinds of networks that necessitated the invention of more complex languages, and the elaborate imaginative mental life they enabled.

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THE HUMAN SOCIAL MIND AND THE INEXTRICABILITY OF SCIENCE AND RELIGION

Mark Nielsen

Whether we go back 60,000 years to indigenous Australians' Dreamtime beliefs or even further to our Neanderthal cousins burying their dead (Rendu et al., 2014), there is a long history of *Homo* behavior being governed by some kind of supernatural belief system. The vast majority of the world's current population identifies with a religious group (according to the Pew Research Center the figure is eight-in-ten: www.pewforum.org/2012/12/18/global-religious-landscape-exec/). We are, by any measure, a religious animal.

Multiple reasons have been proposed to explain why religions have such a hold on our psychology. Irrespective of the reasons, many scholars and commentators have expected this hold to weaken concomitant with increasing reliance on and understanding of scientific frameworks. As Bertrand Russell allegedly¹ once said: "Religion is something left over from the infancy of our intelligence, it will fade away as we adopt reason and science as our guidelines." In this chapter, I will outline why this view is ultimately unsustainable: It fails to account for the way in which our social-cognitive inclinations are framed by cumulative culture, which paradoxically supports technological discoveries and advances (of which science is an expression) while simultaneously supporting the maintenance and transmission of functionally irrelevant practices (which feature prominently in most religions).

Cumulative culture and social learning

"Cumulative culture" is the term used to describe how innovations build on each other and are progressively incorporated into a population's stock of skills and knowledge, generating ever more sophisticated repertoires (Tennie, Call, & Tomasello, 2009). Claims may exist for cumulative culture in other animals (e.g., Vale, Davis, Lambeth, Schapiro, & Whiten, 2017), but there is no parallel to its expression

in humans in terms of complexity or diversity (Dean, Vale, Laland, Flynn, & Kendal, 2013). For many authors, cumulative culture is built on the twin pillars of imitation and innovation (e.g., Legare & Nielsen, 2015; Whiten, McGuigan, Marshall-Pescini, & Hopper, 2009). Imitation is critical as it permits a vast array of skills and behaviors to be transmitted from generation to generation while avoiding the risks and potential costs associated with individual learning. Infants can learn how to use novel objects by watching and copying what others do with them from the middle of their first year (Barr, Dowden, & Hayne, 1996; Meltzoff, 1988). By 2 years of age the proclivity to learn by observing others intensifies to the extent that children will copy obviously causally irrelevant actions, in what has come to be known as overimitation (Horner & Whiten, 2005; Lyons, Young, & Keil, 2007; Nielsen, 2006).

Establishing this phenomenon, Horner and Whiten (2005) had an adult human demonstrate how to extract a reward from a novel box to 3- to 4-year-old human children and wild born chimpanzees. A bolt on the top of the box was first removed, revealing a hole into which a stick tool was repeatedly jabbed. A door located on the front of the box was then opened, and the stick was used to extract the reward. Critically, when the stick was jabbed into the top hole it struck a barrier and made no contact with the part of the apparatus from which the reward could be retrieved, but because the box was opaque it was not possible for these actions to be identified as causally unrelated to the outcome. When given the box to explore, both chimpanzees and children copied the model's suite of actions, including jabbing the stick tool in the top. However, when the opaque box was substituted for a transparent box (making the effect of the internal actions identifiable) the chimpanzees copied only the model's insertion of the tool into the front hole. They ignored the initial action, which was now obviously, causally irrelevant. In contrast, the children replicated the model's entire sequence of actions, including the visibly irrelevant insertion of the stick into the top hole. Subsequent research has established that children's inclination to overimitate increases with age (Marsh, Ropar, & Hamilton, 2014; Nielsen & Tomaselli, 2010), persisting into adulthood (Flynn & Smith, 2012; McGuigan, Makinson, & Whiten, 2011), and is prevalent to varying degrees in contrasting cultural groups (Berl & Hewlett, 2015; Nielsen, Mushin, Tomaselli, & Whiten, 2014).

To date, there is no evidence of overimitation in any living nonhuman species, even in animals that may be expected to demonstrate it because they share with humans a close evolutionary relationship, such as common chimpanzees, bonobos, and orangutans (Clay & Tennie, 2017; Horner & Whiten, 2005; Johnston, Holden, & Santos, 2017; Nielsen & Susianto, 2010), or a close domestic relationship, such as dogs (Johnston et al., 2017). When, then, might a modern human propensity for overimitation have emerged, and what might it have been built on? For a number of theorists, the answers can be found in the Palaeolithic.

The origins of overimitation

From around 1.8 million years ago, our *Homo erectus* ancestors were faced with competition for plant foods from terrestrial monkeys as a direct result of expanding

open environments caused by a global cooling and drying trend, and the challenge of unpredictable food availability due to colonization of novel savanna habitats and habitats outside Africa (Tomasello, Melis, Tennie, Wyman, & Herrmann, 2012; Vaesen, 2012). One possible response to these challenges would have been to scavenge large carcasses killed by other animals – but due to the need to fight off competing carnivores this would have required multiple, cooperating participants. Those who decided to do this, forsaking smaller, individually obtainable rewards for larger rewards that necessitated working with others, accrued a survival advantage. At some point this scavenging transitioned into active collaborative hunting and gathering, in which individuals had to create together various coordination strategies, which they then could communicate cooperatively to others within and across generations (Sterelny, 2012; Tomasello et al., 2012). These ecological pressures also likely underpinned cooperative breeding to help juveniles whose earlier foraging strategies no longer worked well and hence needed assistance to develop appropriate skills (Vaesen, 2012). This would have further impacted emotions and motivations for collaboration and altruism (Hrdy, 2009).

With the emergence of cooperative hunting and breeding came the need for a new psychology: the necessity to coordinate and communicate about decision-making to ensure the smooth formulation of joint goals. In order to do so interactionists need to know, together, that each has the goal of working with the other (Bratman, 1992), which means engaging in some form of recursive mind-reading (we each know that the other knows, etc.). This forms the basic cognitive ability that has enabled humans to engage in all forms of shared intentionality: collaborative interactions in which participants have a shared goal (shared commitment) and coordinated action roles for pursuing that shared goal (Tomasello, 2009).

In line with this is early evidence of social activity in the form of cooperation underpinned by shared intentionality (Shipton, this volume). Perhaps the best indication comes from Isampur Quarry, a 1.21-million-year-old Acheulean site in India (Shipton, 2013). There, a giant slab core was discovered weighing about 65 kg and showing a series of flake scars struck from the side on which it was lying when found, suggesting it had been turned over after having been retrieved from the bedrock. Both retrieval and turning could conceivably have been done by an individual, but it would have been much easier if at least two individuals were involved. More convincingly, knapping such a large core would have relied on striking with large hammers held in two hands – making it likely that another individual was needed to stabilize the core in a process requiring explicit role differentiation (Shipton, 2013).

As is hopefully evident in the preceding text, cooperation has its basis in intention reading, where intentions are considered to be plans of action organisms choose and commit to in pursuit of a goal. According to Tomasello, Carpenter, Call, Behne, and Moll (2005), intentions commonly result in observable behavioral outcomes and are often accompanied by such things as signs of effort and direction of gaze. Reading others' intentions relies on capacities for monitoring current reality, if the action executed is intended and what results is produced by the action. For Tomasello et al. (2005) earlier members of the genus *Homo* developed especially complex skills of

intention reading in the context of the imitative learning of complex tool-using and toolmaking activities. The Oldowan Industrial Complex is a candidate for such activities.

Associated with Australopithecines and early *Homo*, the Oldowan dates from around 2.6 to 1.4 million years ago (although see McPherron et al., 2010), and comprises mostly sharp-edged flakes and the cores from which they came (Monnier, 2006). It has been suggested that the shape of these tools was largely controlled by the properties of the raw materials used, and hence the tools are likely to have been made through individual trial-and-error learning (Ambrose, 2001; Mithen, 1999; Wynn & McGrew, 1989). However, more recent studies hint that the knappers of Oldowan artifacts understood appropriate platforms and angles to strike at to detach flakes, and how to maintain angles on a core so as to maximize the number of flakes that could be struck from it (de la Torre, 2004; Delagnes & Roche, 2005; Dietrich Stout, Semaw, Rogers, & Cauche, 2010). This latter notion suggests an understanding of how individual actions relate to the wider manufacturing sequence as it likely involved forgoing the easiest flake removal in favor of a strike that would allow more future removals. Moreover, signs of battering on these artifacts are rare, suggesting hominins knew the appropriate points and angles to strike at. Thus, Oldowan knappers do not appear to have been habitually reinventing the wheel (Shipton & Nielsen, in press), but instead had certain skills maintained across generations. Nonetheless, these tools lack the consistent patterns of assembly that would suggest evidence of culturally determined stylistic traditions (Ambrose, 2001, p. 1749; see also Isaac, Harris, & Marshall, 1981/1996; Toth, 1985). For this, we need to head to ~1.75 million years ago, into the Acheulean.

With its characteristic artifacts, cleavers, and bifacial handaxes, the Acheulean lithic complex is the most persistent of all archaeological cultures (Nielsen, 2012; Rossano, 2017; Shipton & Nielsen, 2015). Key here is that many aspects of Acheulean stone tool construction are counter-intuitive, making it unlikely that their propagation was achieved via processes of independent, non-cumulative invention. For example, when manufacturing a biface to remove mass from one surface one needs to strike it on the opposite surface. Producing thinner bifaces relies on platform faceting and raising the plane of intersection, which involve small strikes at a steep angle on the surface from which one intends to remove mass, followed by a large strike at a shallow angle on the opposite surface (Shipton & Nielsen, In Press). Even after this method is explained, grasp of such techniques to some level of efficiency requires considerable practice (Putt, Woods, & Franciscus, 2014; D Stout, Apel, Commander, & Roberts, 2014).

Further evidence of a sustained cultural tradition comes from the temporal and geographic distribution of the Acheulean: The industry persisted for around 1.5 million years (Beyene et al., 2013; Shipton et al., 2013) and spread as far afield as South Africa and North Wales, and from Morocco to Nepal (Shipton, in press, this volume). The Acheulean even transcends species boundaries, being manufactured by various hominins, including *Homo erectus* and *Homo heidelbergensis*. Moreover, Acheulean bifaces are deliberately shaped to be symmetrical (Shipton, Clarkson, &

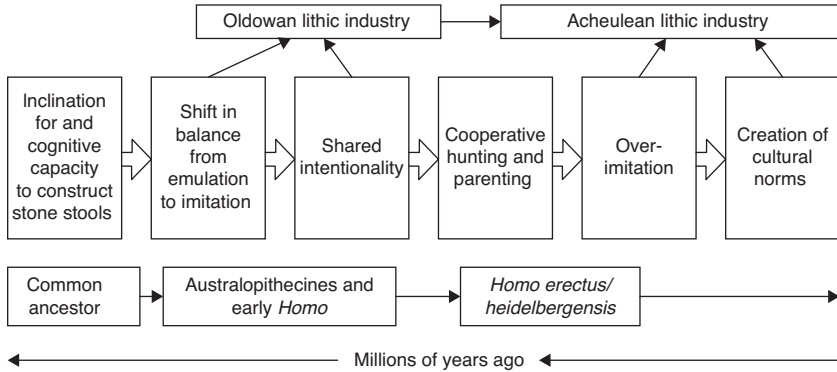


Figure 16.1 The interrelated steps anchored in changes to stone artifact construction through the Palaeolithic leading to the emergence of cultural norms

Source: Created by author.

Cobden, in press), often in two planes, yet butchery experiments suggest this symmetry does not greatly improve their utilitarian value (Machin, Hosfield, & Mithen, 2007). The argument here is that the symmetry and overall morphology of these objects were maintained across multiple generations as an outcome of overimitation of an unnecessarily symmetrical form.

Our closest living evolutionary relative, the chimpanzee, uses stone tools (Mercader et al., 2007). But prevailing evidence suggests these are less cognitively complex than those found in the Oldowan. The implication here is that as we diverged from our *Pan* common ancestor there was already in place the tendency and ability to manufacture basic stone tools (see Figure 16.1). Commensurate with neocortical expansion, this laid the foundation for imitation as a default social learning strategy to take hold. Critically, though chimpanzees are capable of imitating they are far more likely to favor emulating (where the outcome of a demonstrated actions sequence is brought about via one's own means and not those unique to the demonstration). In imitating others' construction of Oldowan tools, shared intentionality began to emerge. This in turn yielded cooperative hunting and parenting, and with them fertile ground in which cultural norms could grow as most evident in the Acheulean, with its bias toward replicating specific actions over the outcomes of those actions. This bias lends itself to another feature of the human mind: our proclivity for engaging in ritual behavior.

Overimitation and ritual

Rituals are conventional, causally opaque procedures. They are uninterpretable from the perspective of physical causality because they lack an intuitive or observable causal connection between the specific action performed (e.g., synchronized dancing) and the desired outcome or effect (e.g., making it rain) (Legare, 2017). Rituals

tend to feature actions that are both causally opaque, affording no access to a physical causal mechanism, and goal demoted, affording little-to-no insight into the motives of the ritual actor (see Kapitány & Nielsen, 2015, 2017). As such, ritualized actions are interpreted as being motivated by social concerns, such as affiliation with group members or group-relevant norms, rather than instrumental purpose (Watson-Jones & Legare, 2016).

There are multiple ways in which children show social and cognitive preparedness to adopt the ritualized behaviors of those around them (Legare & Nielsen, 2015; Watson-Jones & Legare, 2016). According to a number of authors, overimitation is the most compelling (Nielsen, *in press*; Nielsen, Kapitány, & Elkins, 2015; Rossano, 2012, 2017). Overimitation and rituals both focus on the actions used over the outcomes achieved. Highlighting this, in a study by Nielsen and colleagues (2015), preschool children watched an adult experimenter model redundant actions on a box (e.g., tapping the side of it with a tool) *after* the box had been opened. When given the box and tool, children reproduced the redundant action despite there being no causal value in doing so (the box was open at the time the actions were produced, and the toy hidden inside was accessible). Extending this design cross-culturally, young children living in remote Bushman communities in South Africa were shown a sequence of causally irrelevant actions on an opaque box (Nielsen, Tomaselli, & Kapitány, 2018). For some children, the actions culminated in a clear goal being achieved (i.e., a desirable sticker was retrieved); for other children, the goal was made unclear (e.g., the sticker was available but not retrieved) or removed entirely (i.e., there was nothing to retrieve). Children consistently replicated the causally irrelevant actions, but the irrelevant actions were reproduced at significantly higher rates and featured considerable additional repetition when there was no goal. The most ritualistic and least instrumental actions were reproduced at the highest rates. Children easily overimitate, and this proclivity can be simply and easily co-opted to support the uptake of ritualistic actions.

Social motivations

There is ample evidence that overimitation functions to satisfy social motivations, be they affiliative or normative (for reviews see Clay, Over, & Tennie, 2018; Over & Carpenter, 2013). For example, Nielsen and Blank (2011) had 4- to 5-year-old children sit opposite two adult models. Both models took turns demonstrating a sequence of actions on a puzzle box that led to it being opened, making a novel toy available for retrieval. One of the models included irrelevant actions in her demonstration, whereas the other used only causally relevant actions. When the child was given the box to operate on, one of the adults left the test room. The children proceeded to copy the actions of whoever remained – most tellingly reproducing the irrelevant actions when the model who had used them was still present, despite the alternate adult having clearly shown these actions were unnecessary (when the model who used only causally relevant actions remained, children omitted the causally irrelevant actions). Other studies have shown that children will actively protest a

protagonist omitting a causally irrelevant action after having seen it being modeled, and will do so even after stating that they understand the irrelevant action to be unnecessary for achieving the modeled goal (see Kenward, 2012; Keupp, Behne, & Rakoczy, 2013).

In line with this, contemporary experimental archaeology studies have highlighted the likely role of social motivations in handaxe construction (see Putt et al., 2014). Thus, through the Acheulean, we see the emergence of overimitation, a bedrock of cumulative culture and ritual behavior, and with it increasing evidence of a socially motivated mind.

The origins of innovation

Existing from around 1.75 million years ago to around 800,000 years ago, the unparalleled longevity and ubiquity of the Acheulean are considered dependent on a mind that is prone to socially motivated high-fidelity imitation but has little inclination toward innovation (Shipton et al., 2013). Indeed, for more than a million years during the Acheulean the appearance of “new” tools is at best sporadic (Goren-Inbar, 2011; D. Stout, 2011), with the rather repetitive and monomorphic production of Acheulean handaxes suggestive of a general lack of technological innovation (Foley & Lahr, 2003; Hill, Barton, & Hurtado, 2009).

Not until the Middle Palaeolithic, around 300 thousand years ago, do clear signs of functionally innovative approaches to making stone tools emerge (commonly associated with *Homo neanderthalensis*, late archaic humans, and early anatomically modern humans). This period features tools for skinning and preparing meat, hunting, and woodworking (Rots, 2013; Zaidner & Weinstein-Evron, 2012). Here the lithic fossil record transitions from a dominance of handaxes to blades (flakes with a breadth:length ratio of 0.5) that, with a greater length of cutting edge per unit volume of stone, are a more efficient use of raw material than either core or flake tools and require an impressive level of skill to manufacture (McBrearty & Brooks, 2000). In this epoch, not only are more rapid leaps in innovation evident but so too is the emergence of clearly identifiable regional and stylistic variants indicative of cultural traditions and culture areas (Ambrose, 2001; Clark, 1988; McBrearty & Brooks, 2000).

Further, through the Palaeolithic, increased signs of cumulative culture are expressed in increasingly innovative tool technologies and more reliable signs of ritual behavior such as use of pigments, abstract markings on various raw materials, and personal ornamentation (Langley, 2013). Documentation of the dead being buried also emerges in this period (Shipton, this volume). For example, at the Neanderthal site of La Chapelle-aux-Saints in southwestern France, a 50,000-year-old skeleton was found in an artificially modified pit along with evidence that the body was rapidly covered (Rendu et al., 2014). This may not necessarily mean that funerary practices were at play, which would provide stronger indication of engagement in rituals, but it hints at the materialization of attempts at building ritualized bridges between the living and the deceased (Stiner, 2017).

In the Acheulean our ancestors began to take our lineage down a very distinct path. Becoming driven by social over functional motivations, they, unlike any other animal previously or any non-*Homo* animal since, started to focus their social learning interactions on replicating the specific actions more than worrying about the outcomes themselves. This provides firm foundation for passing on specific, culturally dependent methods of doing things. It also created an environment for ritual behaviors to become established. Thus, as overimitation became a more persistent learning strategy, its components (reproduction of causally opaque and goal demoted actions) and motivations (normative/affiliative) provided fertile ground in which cumulative culture and ritual behaviors could flourish. This fertile ground became even richer moving through the Palaeolithic, especially as population sizes grew (Kline & Boyd, 2010; Powell, Shennan, & Thomas, 2009; Shipton, this volume), post-menopausal women became more prevalent (Hawkes, O'Connell, Blurton Jones, Alvarez, & Charnov, 1998; Legare & Nielsen, 2015), and children made up increasing proportions of communities (Langley & Litster, in press; Nielsen, 2012). From here, science and religion could grow.

Cumulative culture and science; ritual and religion

I have recently linked science and religion through their dual reliance on a socially motivated imitative mind (Nielsen, in press). Here I stake this claim more boldly. Science is a process in which theories and hypotheses are put to empirical test and the strength of the resulting evidence subjected to peer evaluation. This may be a simplistic view, though, and it is important to acknowledge that debate over what constitutes the scientific method is far from resolved (Sober, 2015). Irrespective of definition, and despite what some may think, scientists do not operate in a cognitive vacuum. Contemplation of ideas and development of hypotheses to test theories, and theories themselves, do not arise from pure, isolated imagination. Rather they emerge from and are built on an accumulated body of temporally extended cultural knowledge. Scientists do not want to invest in proving theories that have already been proven or disproven. They do not want to invest in developing protocols and paradigms that have been previously established, or been shown as ineffective. Science functions because its practitioners draw on a storehouse of theories and research endeavors that enable theory refinement and the derivation of new questions. Science thus relies on the progressive accumulation of ideas and discoveries that are handed down from generation to generation, building an ever-increasing corpus of skill and knowledge that no single individual could develop in his or her lifetime. In this way, without a cumulatively cultural mind we would not have science.

Attempting to make sense of the wide and varied concepts that researchers use when they define or describe religion, Harris, Howell, and Spurgeon (2018) recently undertook a comprehensive literature review and content analysis. Based on this, they suggest that religiousness can be defined as “a faith concept referring to ritual, institutional, or codified spirituality which is culturally sanctioned” (p. 14). Key here is the mention of ritual. While nonreligious rituals exist (e.g., singing “happy

birthday”) the most diverse and elaborate ones are found among religious groups (Koole, Meijer, & Remmers, 2017). As such, it has been argued that our engagement with rituals in terms of our compulsion to enact them is one reason religions are so pervasive and transmissible (Whitehouse, 2004). Further, for some scholars, participation in ritual lies at the core of all religions such that rituals are not merely important aspects of religious performance or religious existence, but should be thought of as nothing less than religion itself (Wils, 2007). By this reasoning, without rituals we would not have institutional religions.

There is thus evidence for the early emergence, ontogenetically and phylogenetically, of behavior underpinned by social motivations and that these motivations guide (and guided) learning and skill acquisition decisions. Whether to satisfy affiliative or normative concerns, once social reasons are used to drive decisions about what to learn, ritual behavior can easily take hold. A number of authors have previously drawn developmental links between imitation and children’s scientific reasoning (e.g., Buchsbaum, Gopnik, Griffiths, & Shafto, 2011; P. L. Harris & Koenig, 2006) and between imitation and children’s understanding of rituals (e.g., Clegg & Legare, 2016; Liberman, Kinzler, & Woodward, 2018). The novel argument here is that overimitation, by virtue of its socially motivated focus on the precise gestures used rather than the outcomes achieved, provides the bedrock upon which cumulative culture, and thus both ritual and science, is built. Religion is built on ritual because ritual unifies a group around a set of unprovable beliefs. Science is built on ritual because ritual emphasizes methodological precision, and methodological precision lies at the core of hypothesis testing. Science may need additional steps, adding in core components like theory development and empirical testing, as might religion, adding in elements like an appeal to the supernatural, but their psychological origins are the same.

To reframe this, there is something unique and special about overimitation that has not been articulated in debate surrounding this phenomenon. As already alluded to, in overimitation there can be found a mechanism in which technical intelligence and social intelligence interact. What is commonly missed, save perhaps for Whiten et al.’s (2009) “copy all, refine later” proposal, is that despite the inclusion of causally opaque and redundant actions, most overimitation tasks still convey functional knowledge (e.g., how to open a puzzle box). If you can recall and replicate all of the actions shown to you, then you can rapidly acquire the skills needed to perform the shown task. Time wasted trying out your own approach(es), as well as encountering potentially dangerous/life threatening mistakes (e.g., failure to remove toxins from a food item because the process seems irrelevant), is avoided. In this regard, *high-fidelity imitation affords a kind of technical intelligence that is otherwise difficult to come by.*

The flip side to overimitation is, of course, the replication of causally opaque and redundant actions. It is the insistent reproduction of these actions, especially when they are obviously and knowingly irrelevant, that has generated so much attention. The argument is that the precise copying of another’s actions, especially those that hold no causal efficacy, manifests a clear behavioral expression of a desire for affiliation and in-group identification. I might have begun copying your method of

knapping a bifacial axe in order to acquire the skills to do so, but retained aspects that otherwise seem causally irrelevant (e.g., the leg the knapped stone is placed on) to display my identification to you and our group. In this regard, *high-fidelity imitation affords a kind of social intelligence that is otherwise difficult to come by*.

Both scientific and religious thinking thus trace back to this singular form of social learning, which provides a mechanism in which technical and social intelligence can interact. Importantly, this happens in ways that are distinct from other products of cumulative culture (e.g., art, law, politics) in that emphasis is on precision. In science, expectations are that any experiment is conducted with a devotion to rigor and that what is done is precise, describable, and ultimately replicable. Similarly, religious rituals are typically scripted, rule-governed, and tradition-bound. To determine causation (science) and group bonding/identification based on empirically unprovable beliefs (religion) require *doing gestures right*. Other products of cumulative cultural do not have such great dependency on gestural precision. So, in overimitation we have both the beginnings of modern cognition and the foundation for two of humanity's most influential aspects of that cognition: science and religion.

Summary

In the opening paragraphs to this chapter I opined that, contrary to the position of many scholars and commentators, religious belief will not fade away concomitant with increasing reliance on and understanding of scientific frameworks. My reasoning was that both science and religion ultimately share a common cognitive heritage, and because of this we are not equipped to jettison one way of engaging with the world while retaining the other. But there is more to it than this. Fundamentally, they provide different things. The science/instrumental side brings us the technologies and advances that, for example, deliver us 3-D metal printing, artificial embryos, and smart cities (these are the first three items on the MIT 2018 list of Breakthrough Technologies: www.technologyreview.com/lists/technologies/2018/). The religious/social side provides the physical and emotional protection that comes from group binding, along with comfort and a reprieve from existential angst (Mercier, Kramer, & Shariff, 2018). Those in search of one *raison d'être* (science/instrumental advances or religious/social comfort) are unlikely to find it in the other.

At a population level, there is certainly evidence of a contemporary decline in adherence to religious belief systems, at least in “developed” societies. Yet despite popularization of science and reduction of societal-level religious oversight (i.e., the kind that promulgated a “believe or suffer the consequences” approach), there are few societies in which the majority do not identify with a religious belief. This will only happen when the investment in belief systems no longer outweighs the return. To believe, with commitment, requires investment of resources (time, energy, finances, etc.), not least of which is learning and appropriately replicating rituals. If the social support that makes commitment attractive can be found elsewhere, at a lower cost (e.g., alternative support networks coupled with state-subsidized health care systems), the incentive to abandon it becomes a behavioral driver. The

argument here is that it is not science per se that has the potential to replace religion but rather alternative social support systems.

It may seem incongruent, as more and more of our world is explained by those relying on some version of a scientific method, that those appealing to supernatural and untestable approaches have not completely disappeared. Yet it is this way precisely because the mind, driven as it is by social motivations and shaped to copy everything, enables science while simultaneously enabling religion. This mind was shaped over a million years ago when our ancestors began to manufacture artifacts for reasons that transcended pure functionality and satisfied social motivations. This catalyzed the emergence of a devotion to high-fidelity imitation and with it the beginnings of cumulative culture and from there a capacity for science. This same mind became fertile ground for planting ritual behaviors, and from there the path was made for more organized religious beliefs to emerge. The mechanisms responsible for cumulative culture, and by extension scientific practices, are so ingrained in our cognitive architecture that this same mind readily indulges in rituals, and by extension religious practices. Science and religion may be seen as contradictory belief systems, with one a threat to the other (unlike other expressions of cumulative culture). But they should also be seen as complementary expressions of cumulative culture and the technical and social endeavors that are unique to our species.

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Note

- 1 This quote is widely attributed to Russell, but has not been formally verified.

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MARKERS OF “PSYCHO- CULTURAL” CHANGE

The early-Neolithic monuments of Göbekli Tepe in southeastern Turkey

*Oliver Dietrich, Jens Notroff, Sebastian Walter,
and Laura Dietrich*

Changing times, changing minds: the early Neolithic

The development of food-producing subsistence strategies lies at the foundation of our modern world and way of living. One of the regions with early evidence for that fundamental change in human history is the Near East, where the process of Neolithization – i.e., the transition from hunting and gathering to agriculture and husbandry – took place during the so-called Pre-Pottery Neolithic (PPN), which is further subdivided into an earlier PPNA (c. 9,600–8,800 cal BC, gathering of wild plants and hunting of wild animals, the “pre-domestication” cultivation of plants) and a later PPNB (c. 8,800–7,000 cal BC, the appearance of domesticated plants, i.e., so-called founder crops as well as the domestication of goats, sheep, pigs, and cattle), followed by the Pottery Neolithic (PN, communities depending on farming) (Aurenche & Kozłowski, 2001; Lev-Yadun, Gopher, & Abbo, 2000; Verhoeven, 2004; Willcox, 2016).

Crucial change, however, already occurred before the establishment of farming economies, at the beginning of the climatic optimum that followed the Younger Dryas cold spell, i.e., during the Epipalaeolithic and the earliest PPNA. This is when the hunter-gatherer societies of Southwest Asia adopted a (semi)sedentary way of life in villages and began to produce an unprecedented number of artworks. This sudden explosion of imagery has led to serious questioning of the traditional views on the push and pull factors for the start of the Neolithization process, which were mostly based on climate, population pressure, or social triggers (for a summary cf. Verhoeven, 2004). Jacques Cauvin was one of the most influential exponents of a new explanatory framework emphasizing the mental possibilities of humans as a key factor.

He argued that the “revolution of symbols” predating the adoption of agriculture (“ideology before economy”) by millennia was evidence for cognitive change, a new “psycho-cultural” mindset manifest in artwork and the use of symbols that enabled people to experience and interact with their environment in a new way (Cauvin, 2003, see pp. 67–72, 204–211). This new way of viewing the world and perceiving humankind’s role in it as powerful agents with the ability to *change* the natural environment to their advantage would have been at least as important in the process of Neolithization as ecological factors. Although Cauvin’s concrete reconstruction of that mindset – centering around female and bull imagery understood as symbols of a goddess and god – has seen considerable critique (e.g., Cauvin, Hodder, Rollefson, Bar-Yosef, & Watkins, 2001, the discussion emphasizing that, among other things, the development of agriculture and domestication was a long, complex process with multifaceted origins), the notion of cognitive factors driving the Neolithization process has opened new ways of thinking about the mental engagement of the post-Ice Age hunter-gatherers of Southwest Asia at the brink of adopting a new way of life.

The debate has further been fueled by discoveries made within the northern part of the Fertile Crescent, especially Upper Mesopotamia, during the last three decades. This region yields evidence for a social complexity unthought of until recently. Early-Neolithic villages of the region have produced small, circular houses with stone foundations, occasionally also larger, more complex buildings with special meanings (Özdoğan, 2010). Repeated renovation of houses and burials underneath floors indicate continuous use over longer periods. Burial goods and treatment of the deceased (e.g., at Körtek Tepe) may already hint at a socially differentiated society (Özkaya & Coşkun, 2011; see, however, for a critical discussion Benz, Erdal, Şahin, Özkaya, & Alt, 2016). Exchange of materials and the strong correspondences of pictorial symbols and signs indicate that village-communities of Upper Mesopotamia have interacted in a large socio-cultural network that stretched over distances of several hundred kilometers (Schmidt, 2005; Watkins, 2005; Dietrich, Heun, Notroff, Schmidt, & Zarnkow, 2012).

Many sites excavated on a larger scale have produced “special purpose buildings,” often accompanied by a rich iconography, interpreted as loci for communal and ritual activities (Cauvin, 1994; Hauptmann, 1993; Özdoğan & Özdoğan, 1998; Özdoğan, 2010; Schmidt, 2006; Stordeur, 2000; Watkins, 2004; Aurenche, 2007). Places like Çayönü (Schirmer, 1990), Nevalı Çori (Hauptmann, 1993, 2011), and Hallan Çemi in Turkey (Rosenberg & Redding, 2000) as well as Mureybet, Jerf el Ahmar (Stordeur, Brenet, der Arahamian, & Roux, 2000), Tell ‘Abr 3 (Yartah, 2004), Dja’dé (Coqueugniot, 2000), and Tell Qaramel (Mazurowski, 2003, 2004) in Syria are well-known examples. These sites date to the PPNA and PPNB, and their “special” buildings – at the current state of research – seem to outnumber similar constructions known from the Southern Levant, e.g., the impressive communal building from Wadi Faynan 16 in Jordan (Mithen et al., 2011). They are not a short-term phenomenon but show a long continuity. At Çayönü Tepesi, for example, “special purpose buildings” of different layouts have been erected over a period of more than a millennium (Schirmer, 1988; Özdoğan & Özdoğan, 1998). Differing in shape and material, most of these buildings still share some basic features (Özdoğan & Özdoğan,

1998; Aurenche, 2007; Kornienko, 2009; Watkins, 2010). There are usually benches running along the inner walls hinting at gatherings as one of their functional aspects. Furthermore, the buildings are richly decorated and/or equipped with sculptures and exceptional material culture distinguishing these types from the rest of settlement architecture. There are also obvious similarities in the treatment of these buildings in the moment of abandonment (Özdoğan & Özdoğan, 1998): In several cases interior features were partly removed, doorways blocked, and the building backfilled.

Monuments, images, and communities: the site of Göbekli Tepe

At Göbekli Tepe in southeastern Turkey an accumulation of this particular type of “special purpose” architecture was discovered and first excavated by Klaus Schmidt (1953–2014). Situated on a high point of the Germuş mountain range above the Harran plain, the site is best known for its monumental circular buildings, which, dating to the PPNA and early PPNB, are considered the oldest yet known evidence for monumental architecture – coming from a hunter-gatherer milieu (Schmidt, 2012). These monuments are formed of often richly decorated and up to 5.5 m T-shaped limestone pillars connected by walls and bench-like structures along the inner mantles (Figure 17.1).

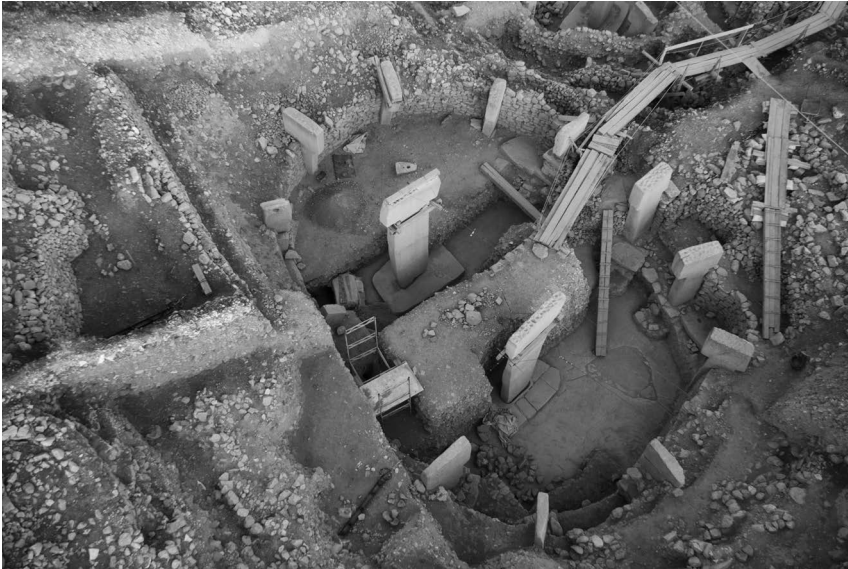


Figure 17.1 Aerial view of Building D in the so-called main excavation area at Göbekli Tepe; central pair of T-shaped pillars encircled by T-pillars connected by walls and stone benches.

Figure 17.1 is to be made available as a downloadable e-resource at www.routledge.com/9781138594500.

Source: Photo: N. Becker, DAI.

There are multiple events and phases recognizable, suggesting that these buildings were in permanent construction and reconstruction, had several phases of use, and were subsequently abandoned (Schmidt, 2012; Piesker, 2014; Kurapkat, 2015; Pöllath et al., 2018). Thus, a considerable workforce, implying the supra-regional cohesion and collaboration of several groups of hunter-gatherers, must be considered for their construction and maintenance. The symbolic meaning of the pillars remains open to discussion. However, many of them are decorated with naturalistic depictions of animals – not exclusively of hunting game (although hunted fauna is represented with, e.g., aurochs, gazelle, boar, and foxes – Figure 17.2), but apparently with a general concern for



Figure 17.2 Selection of reliefs from Göbekli Tepe's characteristic T-shaped pillars depicting: upper left: P2 (Building A): aurochs, crane, and fox; upper right: P9 (Building B): fox; lower left: P12 (Building C): birds, boar, and fox; lower right: P43 (Building D): e.g., vultures, scorpion, and snake.

Figure 17.2 is to be made available as a downloadable e-resource at www.routledge.com/9781138594500.

Source: Photos: K. Schmidt, Ch. Gerber, D. Johannes, DAI.



Figure 17.3 P31 (central pillar of Building D) illustrates the anthropomorphic idea behind at least some of the T-shaped pillars, showing arms, hands, a belt, and a loincloth.

Figure 17.3 is to be made available as a downloadable e-resource at www.routledge.com/9781138594500.

Source: Photo: N. Becker, DAI.

dangerous and supposedly threatening animals like vultures, scorpions, and snakes. Some pillars show arms, hands, belts, and loincloths depicted in relief, allowing us to address them as anthropomorphic representations (Figure 17.3).

The beings are depicted much larger than “life-size” and are intentionally highly abstracted; faces, for instance, are missing. With these characteristic features the T-pillars are distinct from a large number of more naturalistic sculptures found at Göbekli Tepe and other PPN-sites of the region.

Between these are also naturalistic, less than or approximately life-sized human figures (Dietrich, Notroff, & Dietrich, in press), most found incomplete or in fragmented state. While from nearby Şanlıurfa a complete contemporary sculpture is known (Çelik, 2011; Bucak & Schmidt, 2003; Hauptmann, 2003; Hauptmann & Schmidt, 2007; Figure 17.4), at Göbekli Tepe mostly fragments, and here disproportionately

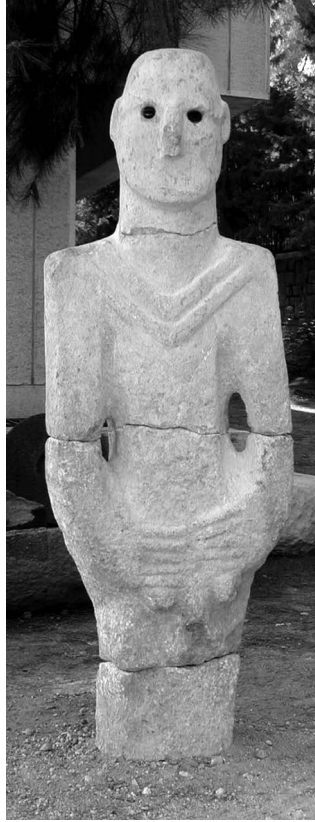


Figure 17.4 The life-sized human sculpture from Şanlıurfa Yeni Mahalle (“Urfa man”).

Figure 17.4 is to be made available as a downloadable e-resource at www.routledge.com/9781138594500.

Source: Photo: I. Wagner, DAI.

often heads, have been documented (Becker et al., 2012). They show breaking patterns in the neck area (Figure 17.5), which make it reasonable to assume they originally were part of larger sculptures.

In contrast to the abstracted and faceless pillar-statues these figures usually have a face (although often the mouth is missing). A selection of these anthropomorphic heads apparently were placed – deposited – intentionally next to the pillars, which hints at complex interrelations between the two groups of imagery (Becker et al., 2012; Dietrich et al., in press). For the buildings excavated so far, certain regularities governing the decoration have also been observed (Peters & Schmidt, 2004; Becker et al., 2012; Notroff, Dietrich, & Schmidt, 2014). While in Building A snake images prevail, in Building B foxes are dominant. In Building C boar are central, and in Building D the imagery is more diverse with birds, especially vultures, playing a

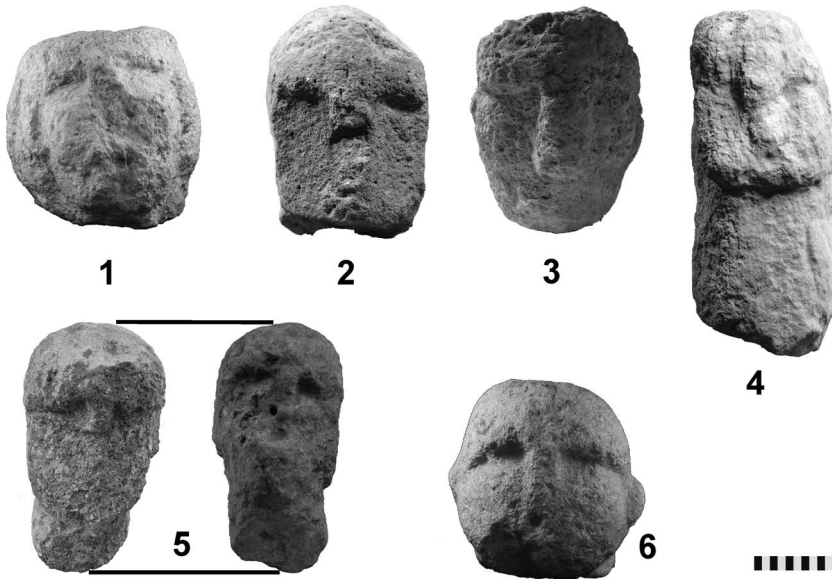


Figure 17.5 Selection of life-sized limestone heads from Göbekli Tepe.

Figure 17.5 is to be made available as a downloadable e-resource at www.routledge.com/9781138594500.

Source: Photos: N. Becker, D. Johannes, DAI.

significant role. In Building H felines are of importance. Interpreting these differences as figurative expression of community patterns could hint at different groups constructing and/or using these buildings, supporting the previous interpretation of the site as a place for supra-regional gatherings or as a meeting point (Notroff et al., 2014).

Naturalistic depictions and abstract symbols not only are present on pillars but were also added to functional objects like shaft straighteners or bowls, and carved into small stone tablets that seemingly served no other function than to bear these signs (Figure 17.6; Köksal-Schmidt & Schmidt, 2007).

There is a strong possibility that the signs were “readable” (Morenz & Schmidt, 2009), fixing memory and knowledge of the society creating them in a form intelligible at least to initiated specialists. Although access to the meanings and narratives behind these depictions is clearly limited by a lack of necessary culture-specific background knowledge (in the sense of Panofsky, 1982; Dietrich & Notroff, 2016), the strong focus on recurring themes emphasizes the importance assigned to the complex iconography, maybe representing central mythological or cosmological views of importance to the groups gathering at Göbekli Tepe – and the rituals taking place there.

The possible catchment area of these gatherings and the likely origin of groups participating are highlighted by a number of common attributes in the material



Figure 17.6 Stone vessel fragment (upper left), stone plaquette fragment (upper right), and plaquettes (below) from Göbekli Tepe bearing symbols and signs contributing to the rich PPN iconography.

Figure 17.6 is to be made available as a downloadable e-resource at www.routledge.com/9781138594500.

Source: Photos: I. Wagner, N. Becker, DAI.

culture. The described iconography appears in concentrated form at Göbekli Tepe and can be followed on other sites throughout Upper Mesopotamia, thus marking a community of people participating in a communication network with a common symbolic background (Schmidt, 2005; Dietrich et al., 2012). Small T-shaped pillars corresponding to examples from a later building phase at Göbekli Tepe (so-called Layer II with rectangular buildings; cf., e.g., Schmidt, 2012; Kurapkat, 2015) were first recorded at the settlement site of Nevalı Çori (Hauptmann, 1993). Several more

sites in the closer vicinity of Göbekli Tepe, among them Hamzan Tepe, Harbetsuvan Tepesi, Karahan Tepe, Kocanizan Tepe, Kurt Tepesi, Sefer Tepe, Taşlı Tepe, and Urfa-Yeni Yol, are known to have produced similar pillars (Çelik, 2014). While most sites concentrate in a rather small radius around Göbekli Tepe, Gusir Höyük in the Turkish Tigris region has considerably widened the distribution area of monumental circular buildings (Karul, 2013). The pillars discovered there are of a slightly different shape, as they are missing the characteristic “T-head.” Other stelae similar to these, however, have been discovered in Çayönu (Özdoğan, 2011) and in Qermez Dere (Watkins, Betts, Dobney, & Nesbitt, 1995). In addition to these two different architectonic regions to the west, in northern Syria a third distinct building style can be observed. Domestic sites like Jerf el Ahmar, Mureybet (Stordeur et al., 2000), or Tell ‘Abr 3 (Yartah, 2013) also have produced circular communal buildings, constructions with pisé walls, and wooden supports. The link between all of these regions seems to be the existence of similarly arranged communal buildings that share a range of common symbols and may be interpreted as defining a “cultic community” (Schmidt, 2012; Dietrich et al., 2012; Figure 17.7).

A supra-regional, functional interpretation of this “special architecture” and of the associated imagery is challenging and complex. However, a closer inspection of the spatial disposition and structure of the backfilling material at Göbekli Tepe allows one to draw a number of conclusions. Communal working areas, e.g., for the processing of food, were discovered, apparently oriented toward the monumental

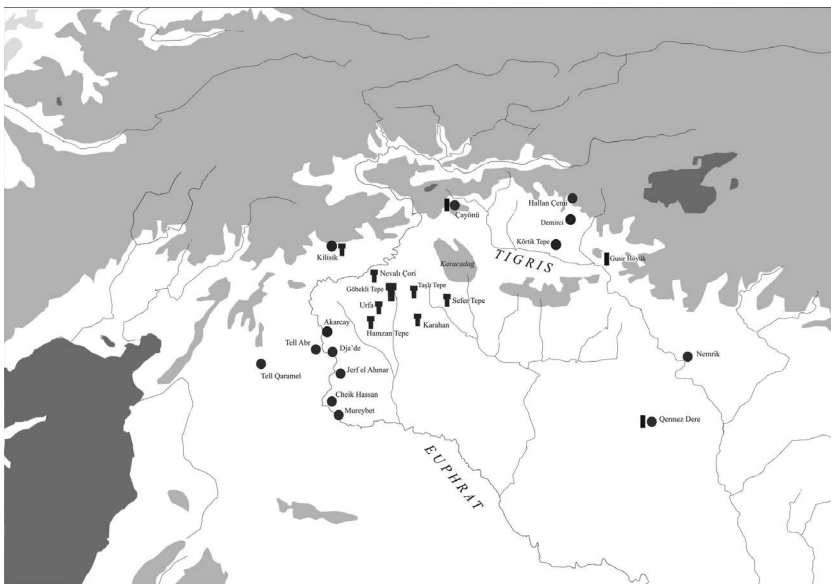


Figure 17.7 Current distribution of known sites with T-shaped pillars and limestone stelae
Source: After Schmidt, 2012, modified by O. Dietrich, DAI.

buildings (Dietrich et al., 2019). Likely roofed and thus not visible/accessible for everyone (Kurapkat, 2015), these buildings still seem to have been situated in the center of the constructed area, their construction implying important communal (work) events.

After their abandonment, some effort was undertaken to at least partly cover and fill these circular monumental buildings with accumulated “waste” (Pöllath et al., 2018), the space spared from later construction activity. The filling material consists of pieces of limestone rubble and flint flakes, as well as fragments of stone vessels, grinding stones, and other ground stone tools. Furthermore, there is an impressively large number of animal bones present. These represent wild game strictly, primarily gazelle, but wild cattle, particularly rich in meat, are prominent as well (Peters & Schmidt, 2004). This noteworthy amount of animal bones, often broken and showing cut marks and traces of burning, speaks in favor of the consumption of great amounts of meat, likely in the course of large feasts. In her study on feasting evidence from Southern Levantine sites, Twiss (2008) has proposed a list of indicators to pinpoint this social practice in the archaeological record. Many of these indicators could be traced at Göbekli Tepe (Dietrich et al., 2012, 2017; Notroff et al., 2014; Dietrich et al., 2019). Feasting as a common mode for executing large communal tasks (and monument construction certainly qualifies as such) has been highlighted in the ethnographic literature (e.g., Dietler & Herbich, 1995; Hayden, 2009).

In traditional societies, feasting is closely connected to ceremonies and rituals (Sommer, 1992). The buildings at Göbekli Tepe indicate cultic activity (Schmidt, 2012; Dietrich & Notroff, 2015). The “special” buildings have been addressed as communication spaces, the performed rituals imagined as opening channels to interact with the supernatural, important ancestors, or totems of the respective groups (Peters & Schmidt, 2004; Busacca, 2017; Fagan, 2017). In archaeology, in particular considering prehistoric periods without written sources, the nature, performative aspects, and purposes of rituals often cannot be reconstructed completely due to a lack of direct evidence and remains. Nevertheless, through material culture, paraphernalia, and architecture there is a chance to get a step closer to these. J. Z. Smith (1980, 1987) introduced the important role of specific and meaningful spaces as a “focusing lens” for rituals, as locations, where “in all form of communication static and noise . . . are decreased so that the exchange of information can be increased” (Smith, 1980, p. 114, 1987). The arenas of ritual performance, their fittings, and furnishings thus offer a good starting point to understand the character of prehistoric ritual.

Rituals, memories, and identities

Göbekli Tepe’s iconography centers on the depiction of powerful and dangerous animals (Peters & Schmidt, 2004; Schmidt, 2008, 2010; Notroff, Dietrich, & Schmidt, 2016). Snakes, leopards, scorpions, wild boar, and aurochs are prominent in this imagery. Often, these animals are depicted attacking (change to aurochs, for instance, are usually shown with lowered head and presented horns; foxes are leaping as if approaching prey, or in a threatening pose; snakes appear as whole packs; and

scorpions are over-sized [Schmidt, 2012]). Almost always an emphasis seems to lie on movement and motion (Busacca, 2017), which gives the animal figures an expression of being animate and alive. Some of the boar or predator sculptures are shown with a clearly visible rib-cage. This could have been intended to signify the agility of these animals or, as an expression of starving, a sense of danger again. Another explanation might well be the indication of death and mortality. Such images, also known from many other sites of the Near Eastern Neolithic (Hodder & Meskell, 2011) and even beyond (Huth, 2008; Schmidt, 2013), reflect not only the dual symbolism of hunter and prey, life, and death, etc., but also the close relationship between these principles.

At a second glance even more amicable animals like birds may have held similar connotations. From Göbekli Tepe, as well as other PPN sites, sculptures of birds sitting on top of human heads or carrying these away are known, an imagery apparently related to Neolithic funerary ritual (Dietrich et al., in press). This seems to be reflected in the already mentioned special treatment of life-sized anthropomorphic sculptures at Göbekli Tepe. During the at least partially intentional refilling/burial of the buildings, the heads of human sculptures would be broken off and deposited inside the fillings, usually next to pillars (Becker et al., 2012; Dietrich et al., in press). The special treatment of separated sculpture heads is evocative of another cultic practice known from the Near Eastern PPN where human skulls (excarinated and separated from the rest of the body) were removed from burials, remodeled, displayed, and reburied (Kenyon, 1953; de Contenson, 1967; Lechevallier, 1978; Rollefson, 1998; Goring-Morris, 2000; Stordeur & Khawam, 2007) – maybe as part of an elaborated ancestor cult (Bienert, 1991; Bienert & Müller-Neuhof, 2000).

Due to their anthropomorphic yet larger-than-life appearance the T-shaped pillars (or at least some of them) may represent ancestors (or even supernatural beings) too. Similar to a cultic community during a ceremony, they stand along the walls of the buildings, “looking” at the center, where another two pillars have been erected. The animals carved into the pillars’ sides appear as parts of their bodies, leading to the impression that the monumental anthropomorphic beings control the powerful animals, and so possibly also life and death.

Summing up, it would seem that some of the imagery of Göbekli Tepe can be linked to concepts of life and death, as well as burial rites, that apparently may have been applied even to at least a part of the anthropomorphic depictions. This suggests that pillars, sculptures, and architecture as a whole might belong to this context – providing a probable frame of reference for the activities taking place at and within these buildings. Although corresponding paraphernalia are rare, further hints at possible ritual performance come from a number of stone objects that have been interpreted as miniature masks (Dietrich, Notroff, & Dietrich, 2018). Assuming these stone masks are indeed *en miniature* representations of masks actually worn, they could well attest that activity at Göbekli Tepe could have included masquerades up to the point of reenacting mythological narratives whose existence is already implied by some of the more complex scenes depicted on pillars that are clearly exceeding a mere decorative character (Schmidt, 2006; Dietrich & Notroff, 2016). Such activity is further emphasized by several peculiar crane depictions. Their unusual

human-like legs contradict the otherwise detailed and correct naturalistic depiction of many other birds' anatomical details – and therefore might indeed indicate masked humans (Schmidt, 2003). This idea finds some confirmation in the remains of a possible “crane costume” reported from Çatalhöyük (Russel & McGowan, 2003; Notroff & Dietrich, 2017). This kind of masquerade might have been seen in the context of shamanistic transformation into spirit animals (Benz & Bauer, 2015). Body modifications could be another important aspect, as some images could be interpreted as evidence for scarification (Dietrich et al., 2018). All these elements can help to clarify the nature of rituals held at Göbekli Tepe and their basic symbolic meanings for the people building and using the site.

The construction of the Göbekli Tepe monuments and their decoration must have been highly labor-intensive (Notroff et al., 2014) and needed organization, cooperation, and leadership (Dietrich, Notroff, & Schmidt, 2017). The question is: To what societal needs were these large-scale and highly complex construction projects and meetings of possibly widely distributed communities, including feasting and the performance of rituals, a response? What drove people to this previously unseen, enormous investment?

At the transition from Epipalaeolithic to PPNA, during a time when the climate was changing to more favorable conditions, with growing natural food and fuel resources, the mobility of people decreased, whereas population size increased (cf. Watkins, 2017). Different from the mobile, probably rather egalitarian hunter-gatherer bands of the Palaeolithic, people of the early-Neolithic communities were living now as larger groups in permanent settlements, in societies with stronger social differentiation and probably evolving hierarchical structures (cf. Clare, 2016). On the one hand, living in larger groups had advantages, such as cooperative hunting, food sharing, defense, and the possibility of specialization. On the other hand, probably intra-group competition for status increased, as well as the danger of conflicts and of differing individual investment into the community (cf. Sosis, 2003; Watkins, 2017).

Even more complex are the social relations between members of different local communities in a large regional network as observed in PPN Upper Mesopotamia (Schmidt, 2005), fluctuating between cooperation (e.g., exchange of goods, like obsidian) and competition for resources (Watkins, 2005). Thus, at the transition to the Neolithic probably the need to support intra- and intergroup cooperation as well as for peaceful forms of competition increased. The sharing of food, especially of meat from big-game hunting, as indicated for the feastings at Göbekli Tepe, likely has been of great importance in the evolution of human social behavior (McGrew & Feistner, 1992). In hunter-gatherer societies, food sharing is essential for group cohesion (Benz, 2010), but in industrialized societies the sharing of food also has an important social function.

Not all group members may be willing to contribute to the community (i.e., share their resources with others). “Costly signals” are credible indicators for the commitment of a group member to the community and his or her intention to cooperate. Costly signaling supports trust and group cohesion and helps to gain prestige (e.g., Zahavi & Zahavi, 1997; Sosis, 2003). Taking part in the labor-intensive

building activities at Göbekli Tepe and/or providing food and materials for ritual feasting may be understood as costly signaling of individuals as well as of groups (cf. Watkins, 2017). Likewise, the impressive buildings were displays of the strength, economic power, and creative capability of the respective community. So, the cluster of neighboring, possibly in part contemporaneous, megalithic buildings at Göbekli Tepe might represent at the same time signs of cooperation and competition.

As compared to building activities and feasting, the rituals that were performed at Göbekli Tepe might have had equally (or even more) important functions. Hobson, Schroeder, Risen, Xygalatas, & Inzlicht (2018) identify three basic psychological functions of rituals: first, the regulation of (especially negative) emotions (rituals, e.g., reduce anxiety and alleviate distress caused by threatening and uncontrollable situations). If the earliest Neolithic had been a time of social and economic upheavals, but also in the confrontation with dangers of the natural environment (e.g., during hunting), rituals may have functioned as psychological stabilizers. Second, rituals can motivate people to reach a goal (difficult physical as well as cognitive tasks). Third, rituals are important means for the regulation of social connections. Rituals integrate “an individual’s subjective state with the communal social order”; when performing a ritual together with others “a person affiliates with fellow group members” and “learns cultural knowledge while observing it” (Hobson et al., 2018, p. 270). Both fostering social bonds and group cohesion as well as conveying cultural knowledge were probably important aspects of the rituals performed at Göbekli Tepe.

Walter Burkert (1997) has highlighted the impact of the hunting and killing of animals, and of constantly suppressing biological killing taboos on human societies. He identifies the sacrifice, and in particular the blood sacrifice, as a fundamental experience of the sacred. “Homo religious” has always been a “Homo necans,” he argues, and the hunt is seen as just another variation of sacrifice due to a number of similarities between both acts: that is, special preparations of participants (cleansing, abstinence, etc.) or specific treatment of game and trophies by hunters in the course of completion rites (Burkert, 1997, see pp. 21–24).

Burkert (1997, pp. 24–27) emphasizes the very act of killing as essential for anatomically modern humans as species. Their ability to create and use weapons together with a high degree of cooperation ensured the superiority of humans as opposed to the animal world. Hunting is “a man’s world,” so it is men who continuously have to change between a social “inside” realm of daily life within family and community and an “outside” realm of aggression, violence, and killing. While aggression and killing are essential in one realm to ensure survival, they have to be strictly sanctioned in the other to enable peaceful coexistence. Hunting and killing on the other hand also create a strong communal spirit, a feeling of solidarity – and they have to, since only this way can larger prey be successfully brought down. Sooner or later any male descendant of a hunter group thus has to accomplish the transition into this “outside” realm – into the group of individuals able and allowed to kill.

The dependence on animals and the close contact hunters have with their behavior according to Burkert lead to the association of human traits to the prey. The

consequence is a sense of fear and guilt resulting from the act of killing (Burkert, 1997). Burkert also sees religion and ritual not as a means to relieve this stress, but on the contrary, as increasing it to tear down the barriers when it comes to killing. Aggression and death are key subjects for hunters, and strong communal bonds have to be built to overcome natural inhibitions to killing. This would be mirrored in the rituals performed by such groups.

In an evolutionary perspective, the emotional intent and effect of rituals as well as their social and psychological consequences have been thoroughly described and discussed by Whitehouse (1995, 1996, 2000, 2004; Whitehouse & Lanman, 2014). He developed his *theory of divergent modes of religiosity*, based on ethnographic fieldwork in Papua New Guinea (Whitehouse, 1994, 2000) and with a view to recent approaches in cognitive science. Following the constitutive question of how religions emerge and which role rituals, ritual performance, and the psychological effects capture in this process, Whitehouse developed a model proposing different ritual practices leading to particular emotional responses and group dynamics among participants. This approach very much focuses on the psychological effect of rituals, their staging, and their enactment on participants. Differing ritual patterns are thus utilized to advance specific knowledge, traditions, and contents.

Two variations of ritual modes are at the basis of Whitehouse's model (Whitehouse, 2002): The first of these, a "doctrinal mode," emphasizes high frequency, low arousal rituals aiming at the intermediation of basic and essential conventions and principles. Whitehouse and Lanman (2014) attribute this mode to rather large, complex, hierarchically organized societies. The second, "imagistic" mode refers to low frequency, high arousal rituals characterized by dysphoric events resulting in more permanent autobiographical memories (Whitehouse, 2002). Rituals following this mode should be more characteristic for hunter-gatherer societies (Whitehouse & Lanman, 2014).

In imagistic rituals, through the collective experience of fearful or even painful situations, cohesion among participants can be strengthened to an utmost degree of "identity fusion" (Swann & Buhrmester, 2015). In this extreme form of group cohesion, the boundaries between personal and social (i.e., community) identity are blurred, shaping particularly strong relational ties among group members and pushing extreme behavior in favor of the whole group (Swann, Gómez, Dovidio, Hart, & Jetten, 2010). According to Whitehouse dysphoric episodes and increased arousal are necessary in the context of these rarer rituals (e.g., one-time initiations or other rites of passage) to create a permanent and enduring impression.

While imagistic rituals produce rather episodic but particularly emphatic memories, doctrinal rituals with their repetitive character aim to create general knowledge of culture-immanent content via semantic memory. Effectively, relational bonds between participants and among the groups operating in the framework of these rituals also depend on the different agency of intended output: a rather cursory, less intense group identity promoting cooperation in the doctrinal mode versus a strong individual dedication and unity in the imagistic mode. In archaeology, this approach has been recently adopted and tested for the complex imagery, material

culture, and architectural installations of the Neolithic site of Çatalhöyük in Turkey (Whitehouse & Hodder, 2010).

Given the characteristics of Göbekli Tepe’s iconography and paraphernalia discussed earlier, rituals held at the site may indeed be described as “imagistic” in nature: The imagery is centered on fear (dangerous and aggressive animals), a mythology related to death, and male sexuality. There is an emphasis on hunting at the site that may go beyond the mere needs of subsistence. The easy-to-catch gazelle was not the only species regularly targeted to supply feasting activities. A second important meat animal was aurochs (Peters & Schmidt, 2004). But why hunt dangerous aurochs when there is an abundance of gazelle? It seems possible that targeting aurochs may have served another function than just a supply with meat – maybe related to the function of and activity taking place in these buildings, since the animal prominently features in their decoration as well (Pöllath et al., 2018): activities possibly related to hunting rituals and in particular to the initiation into these hunters’ circles. Much in concordance with Whitehouse’s model (Whitehouse, 2002), initiation rites including the hunt of fierce animals and the symbolic descent into an otherworld (especially if the buildings were roofed), and the symbolic death and rebirth as an initiate, could well have been aspects of “imagistic” rituals at Göbekli Tepe, thus reinforcing group identities and the acceptance of new members into a group.

Some features of the buildings, however, alternatively could be interpreted as belonging to Whitehouse’s doctrinal mode. The pictures appear as a code system; the pictorial “signs” seem to be arranged in a text-like, “readable” manner (Morenz & Schmidt, 2009; Morenz, 2014). On several pillars the depicted figures are arranged in complex compositions. The figures’ actions and interactions seem to tell stories (Schmidt, 2012). A central purpose of the decoration thus might have been to convey mythological knowledge in a doctrinal manner. Recently, Henley (2018) used Göbekli Tepe to highlight the social phenomenon of storytelling, which has been shown to be in hunter-gatherer societies closely connected to cooperation (Smith et al., 2017). Regarding the size of the buildings at Göbekli Tepe, probably only part of the communities that were involved in their construction could participate in the ritual performances inside the buildings (McBride, 2013). The character of these groups, marked by emblematic animals and important aspects of mythology carved and preserved in stone, remains unclear at the moment. Clans or tribes could be a possibility, but also other organizational structures, which cross-cut those based on ancestry, like secret societies, may be considered (cf. Hayden, 2018; see also this volume).

Conclusion: rising actors in a changing world

Interpreted as places of meeting and gathering (e.g., Cauvin, 1994; Hauptmann, 1993; Özdoğan & Özdoğan, 1998; Schmidt, 1998, 2006; Stordeur, 2000; Watkins, 2004), the peculiar accumulation of “special purpose buildings” at Göbekli Tepe has to be considered an indicator of the outstanding role of this site and the activities taking place there – with the monumental architecture as a focal point. Different

groups seem to have engaged in feasting, interchange, and cultic activity at what may best be described as a “social hub” (Clare, Dietrich, Notroff, & Sönmez, 2018). The development of larger and more complex local communities, and increased interaction and interdependence of members of different communities during the earliest Neolithic, required probably mechanisms to strengthen group cohesion. One psychological mechanism might have been costly signaling of commitment, i.e., increased investment into communal tasks (such as erecting buildings, providing food for large feasting, etc.), another the performance of rituals.

By offering a basic ground to contextualize values and meanings, rituals help in the sharing and perceiving of common ideologies, philosophies, and conceptions of the world. Rituals, characteristic constituents of human communities, not only reflect social structures within, but between, groups – they represent the fundamental mechanisms for creating and maintaining social bonds and, subsequently, group cohesion. Following specific structures and rules, rituals create particular psychological effects on both the participants and attendees of a formally staged event. Emotions cannot only be created, but – maybe even more important – be directed through the means of ritual performance. Very probably, a main function of the “special” buildings at Göbekli Tepe has been to bind (members of) communities together through the collective experience of ritual performance.

The observed combination of features pointing to rather “imagistic” rituals and those apparently rather connected to a “doctrinal” mode at Göbekli Tepe may indicate a transformation of not just rituals but religious thought. According to Whitehouse and Lanman (2014), imagistic religions are rather adapted to hunter-gatherer ways of living, the doctrinal mode to larger, more complex, hierarchic societies. The monumental buildings at Göbekli Tepe could thus be understood as material expressions of the transformation of hunter-gatherer religious thought and ritual to a religion adapted to sedentism and hierarchically organized communities that are connected in large networks. A first analysis of the site and its exceptional features from a psycho-archaeological perspective has been provided by Benz and Bauer (2013, 2015), resulting in a discussion of shamanism and the origin of institutionalized religion as the consequence of growing social networks in the course of the Neolithization process.

Cauvin’s notion of cognitive change preceding and contributing to the development of food-producing subsistence strategies may find some proof in Göbekli Tepe and other “special buildings.” Göbekli Tepe occupies an outstanding position in a period when these important innovations in human history took place. The execution of large communal projects before this innovation leap has widely changed our understanding of early sedentary societies. The many pictorial works found at Göbekli Tepe and other sites in Upper Mesopotamia document how the early-Neolithic study of nature reaches a new quality, as compared to the Palaeolithic. PPNA depictions of insects, for example, and their different life stages indicate a close observation and probably also a changed interest in and understanding of the natural environment and processes of life (Walter, 2015; Walter & Benecke, forthcoming). With the monumental cult buildings, ritual or cultic practices are separated from

the natural environment and enclosed in artificial constructions. At the same time, the natural world and in particular animals, apparently subordinated to or controlled by anthropomorphic beings, are incorporated, almost “caged” within these structures and instrumentalized to fulfill peculiar social functions for these early-Neolithic societies. Whereas the pictorial works document the strong interest in the natural process of life (and death), Göbekli Tepe’s buildings thus might be considered the materialized expression of a mental detachment from nature to some degree – and the beginning perception of Neolithic communities as not just being part of nature, but becoming actors capable of manipulating and transforming their environment.

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18

HOW RITUAL MADE US HUMAN

Matt J. Rossano

Sergio Catalan could be forgiven for being wary. As he checked on some cattle at the foothills of the Andes Mountains, he spotted two scraggly-haired, emaciated “mountain men” frantically waving at him from across the Rio Azufre. The rushing current made it impossible to hear them, but their desperation was obvious. Who were these men? Bandits? Drug dealers? Revolutionaries on the run from the Army? As one of them drew nearer to the river bank, his eyes locked with Catalan. Then he stopped, just short of the river, fell to his knees, and with hands clasped to the heavens, he begged for his life. Catalan’s heart was moved. Where once had been trepidation, pity now swelled. “Tomorrow,” he shouted to them. As promised, Catalan returned the next morning, saving the lives of the two young men and their 14 companions back at the crash site, 12,000 feet high in the Andes Mountains. Catalan’s encounter with the wild-looking “mountain men” was the beginning of the end of what has come to be known as the “Miracle in the Andes.”

On October 13, 1972, a chartered plane carrying the Old Christians rugby club of Montevideo, Uruguay, crashed in the Andes Mountains. The team, along with family, friends, and others, was on its way to Santiago, Chile, for a match. When rescue efforts failed, the world assumed the worst. But 16 of the original 45 passengers survived ten weeks stranded in the mountains. The fact that their survival required anthropophagy (using the bodies of the dead as food) stirred international attention.

For this chapter’s purposes, however, it is the encounter with Catalan that is more significant. For in it we see that which distinguishes *Homo sapiens* from all other species. The two “mountain men” – Roberto Canessa and Nando Parrado – were close to death from exhaustion. They had trekked ten days across the Andes Mountains, a journey that had taken them up and over a 15,000-foot peak without any mountain-climbing equipment or training. By the time Catalan saw them, Canessa had collapsed from dysentery and was sitting listlessly against a tree while Parrado gathered sticks and other combustibles near the river bank. Parrado was in better

shape physically, but he was badly nearsighted and had lost his glasses weeks ago in the plane crash. Canessa was all but immobile, but he had good eyes. He spotted Catalan across the river. With the words “I see a man,” Canessa initiated the dramatic encounter, wherein the very essence of humanity was put on display – that being our unmatched cooperative abilities.

Upon hearing the words, Parrado ran recklessly toward the riverbank. His nearsightedness combined with the late afternoon’s long shadows made it impossible for him to clearly distinguish Catalan across the river. Canessa attempted to guide him – “to the left. No, no, too far, to the right.” It would have been slapstick comedy if the stakes had not been so terribly high. Instead, it was human cooperation, *par excellence*: the lame leading the blind in a joint effort to save their lives. We also see the mechanism by which humans have forged cooperation over the course of our evolutionary history: ritual. Once Canessa got Parrado more-or-less lined up with Catalan, somehow Parrado had to convey the crucial message: “For the love of God do not fear us. Save us.” He did that by using a ritualized act, understood by any human across the globe. He fell to his knees and begged for his life. With that gesture, all divisions of nationality, social class, age, and education dissolved. One needed only to be human to understand the message.

In this chapter I shall try to present a credible case for the idea that it is ritual that makes us human and it is because of ritual that we are here. More specifically, my case breaks down the following propositions: (1) Humans are unique in their cooperative abilities (more clearly so than our rational abilities). (2) Cooperative communities are constructed using costly rituals. (3) Supernatural belief provided the motivation and the individual fitness advantage necessary for humans to engage in costly rituals. And (4) archaeological evidences indicates that *Homo sapiens* engaged in higher-cost ritual activity than other hominins (specifically, Neanderthals). It was the communal cooperative advantage, constructed using costly rituals, that gave *Homo sapiens* the decisive edge over other hominins as they spread across the globe.

A uniquely rational animal?

Traditionally, humanity has been thought unique among animals by virtue of our rational abilities (Farah & Heberlein, 2007). Humans have rational souls. We possess unique cognitive abilities such as language, theory of mind, abstract thinking, and episodic memory. But as evidence of these faculties accrued in nonhuman species, a clear definition of humanity built strictly on rational terms proved elusive (Hurley & Nudds, 2006; Tomasello & Hermann, 2010). However, Tomasello and colleagues have built a strong empirical case that it is *social* intelligence that separates humans from other species (Hermann, Call, Hernandez-Lloreda, Hare & Tomasello, 2007; Tomasello, Melis, Tennie, Wyman, & Herrmann, 2012; Tomasello, 2014).

For example, Hermann et al. (2007) gave an extensive battery of tests assessing both physical and social cognition to 2-and-a-half-year-old children and two species of our closest great ape relatives (chimpanzees and orangutans). Though the children were barely literate and without any formal education, they surpassed the apes on

tests of social cognition. There were no differences between the children and the chimpanzees on tests of physical cognition. Tomasello and colleagues argued that this provided strong support for the hypothesis that *Homo sapiens* were selected for a unique form of cultural cognition, not found in other apes.

Other studies have shed more light on the specific components of this cultural cognition. An important part of it appears to be a powerful motivation to cooperate with other members of our species.

Children as young as 18 months show surprising cooperative abilities exceeding those of adult chimpanzees. For example, Tomasello and colleagues had children and chimpanzees play the “trampoline” game, where players hold different ends of a large fabric attempting to keep a ball from rolling off (Tomasello & Carpenter, 2005; Warneken, Chen, & Tomasello, 2006). Chimpanzees failed miserably. Unlike human children, they showed no evidence of understanding the importance of complementary roles in achieving the joint objective. By 2 years of age, however, human children were skilled game players, readily coordinating activities to achieve the common end (Carpenter, Tomasello, & Striano, 2005; Tomasello & Carpenter, 2005; Warneken et al., 2006). Unlike chimpanzees, children appeared to understand the different roles from an objective, “bird’s eye” perspective, thus allowing them to easily engage in role reversal (Fletcher, Warneken, & Tomasello, 2012). Furthermore, if a partner quit his or her role, the child often took assertive action to reengage the partner, something chimpanzees never did.

Importantly, chimpanzees’ cooperative failings are unlikely to originate from cognitive shortcomings. Chimpanzees can identify intentional behaviors and infer goals and thus understand that someone reaching for an object intends to possess it (Call, Hare, Carpenter, & Tomasello, 2004; Tomasello & Carpenter, 2005; Warneken & Tomasello, 2006). This allows them to offer simple “helping” behaviors such as retrieving an object for another or assisting another in obtaining food (Melis et al., 2011; Warneken, Hare, Melis, Hanus, & Tomasello, 2007). They can also work with a partner to achieve a joint goal (Melis, Hare, & Tomasello, 2006a; Melis & Semmann, 2010).

Instead, chimpanzee cooperation suffers from a motivational deficit, largely attributable to their social hierarchy. Why cooperate when a more dominant chimp will monopolize the subsequent rewards? This disincentive was demonstrated in two studies where chimpanzees and children worked in same-species pairs pulling on ropes together to obtain treats (Melis, Hare, & Tomasello, 2006b; Warneken, Lohse, Melis, & Tomasello, 2011). The treat was either pre-divided into equal piles or in one big pile. Both chimps and children successfully cooperated when the reward was pre-divided. The difference was in the single pile condition. Children readily divided the pile roughly equally, and thus their cooperation continued. Chimps did not. Their cooperation broke down because the food was always taken by the more dominant chimp.

From these studies, Tomasello (2014) concluded that young children have a “sense of distributed justice that is closely tied to collaborative activities” (p. 189) – something not found in our closest primate relatives. While chimpanzees will protest when

another tries to take food or other desirables from them (e.g., Jensen, Call, & Tomasello, 2007), they do not seem to connect effort with reward.

Something happened over the course human evolutionary history that forced our ancestors to make the connection between cooperation and justice. Tomasello (2014) argues that the key selective event was “obligate cooperative foraging.” At some point in hominin evolutionary history, the most basic survival activity, getting food, required cooperative effort. Those of our ancestors who could not work successfully with others simply “starved” out of the breeding population. The remaining successful cooperators were those who had connected effort with reward in their minds (and “guts”), and thus could be counted on to share when spoils of joint endeavors were realized.

Group competition

Over time, argues Tomasello (Tomasello et al., 2012), cooperatively foraging groups came in contact with one another vying for scarce resources. This initiated a stage of group competition in hominin evolutionary history. In this competition, groups where members were more intensely committed to shared cooperative norms out-competed others. This helps to explain the distinctively tribal minds of humans.

Ethnographic, archaeological, and genetic data support the notion of group competition playing an important role in human evolutionary history. Evidence from traditional societies in both North America and New Guinea indicates that intergroup conflicts were not uncommon. In New Guinea, over a 25-year period, extinction rates for tribes in different regions ranged from 8% to 31% (Jorgensen, 1980; Soltis, Boyd, & Richerson, 1995). A worldwide sampling of hunter-gatherers shows that 64% engage in warfare at least once every two years, and only 10–12% could be considered “peaceful” (Ember, 1978). A specific case study in group competition was carried out by anthropologist Raymond Kelly (1985), who studied the conflict between the Nuer and Dinka tribes in southern Sudan. Kelly concluded that had British colonialism not interfered, the Dinka would have eventually been wiped out by Nuer expansionism.

The archaeological record also provides evidence of increased intergroup interactions. Around 300,000 ybp (years before present), evidence of the procurement and processing of pigment for ritual use emerges (Barham, 2002; Watts, 1999). Around 100,000 ybp, evidence of beads and body ornaments is present (Vanhaeren et al., 2006). These remains suggest that both ritual activity and tribal marking were increasing or intensifying at this time, both indicators of increased intergroup contact and competition (Kuhn & Stiner, 2007; Sterelny, 2014). This evidence is complemented by genetic studies showing a rapid expansion in certain human sub-populations beginning around 70,000 years ago. Archaeologist Paul Mellars (2006) argues that a socially and technologically advanced group of modern humans expanded precipitously at this time, absorbing or replacing both adjacent African hominin populations and, in relatively short order, far-flung archaic hominins worldwide.

Group competition selected humans for a tribal mentality unique among primates, where successful groups would have been populated by individuals with an intense commitment to group norms of cooperation and self-sacrifice. This mentality has been revealed in laboratory studies beginning with the seminal work of Solomon Asch. More recent studies have compared humans and chimpanzees on the extent to which groups influence individual decisions. Haun, Rekers, and Tomasello (2012) found that both chimps and children would allow a “majority opinion” to influence their individual choices. Thus, if the subject did not know which option (A, B, or C) led to a reward, but most other group members selected A, then the subject would select A as well. However, only children would change a known rewarded decision if other group members selected a different option. Thus, if the child had selected option C and it led to a reward, but other group members insisted that A was the proper choice, then the child (not the chimp) would change his/her decision (Tomasello, 2014, p. 191). Unlike chimps, for children it is more important to demonstrate group commitment than to be certain of an individual reward.

Furthermore, children show a heightened sensitivity to in-group reputational status compared to chimpanzees. When being watched, chimps are equally likely to behave selfishly or cooperatively. Not so with 5-year-old children, who were far more likely to behave cooperatively when watched – especially if the observers were in-group members (Engelmann, Herrmann, & Tomasello, 2012; Engelmann, Over, Herrmann, & Tomasello, 2013). What these studies suggest is that from a very young age, children are motivated to exhibit behaviors that identify them as good group members.

Marines vs. hippies

Homo sapiens is distinguished by its unparalleled cooperative abilities. Our intense tribalism – forged by group competition in our ancestral past – is a testament to these sentiments. In this section, I will try to make the case that ritual, *costly* ritual specifically, was the mechanism by which *Homo sapiens* constructed highly cooperative, tribally-minded communities.

Imagine two hominin groups, roughly a half-million years ago, jockeying for control of a scarce resource (a grove of fruiting trees or prime hunting ground). Imagine one group displays the order, discipline, and commitment of a Marine regiment, while the other the laissez faire individualism of a hippie commune. Which is more likely to successfully claim the resource?

Assuming that group competition played an important role in the evolution of our species, it is not unreasonable to assume that more “Marine-like” groups held an advantage over more “hippie-like” groups. More realistically, the point is that group competition selected our ancestors for more Marine-like characteristics compared to hippie-like characteristics. So, what is it that distinguishes Marines from hippies? Attitudinally, Marines live by a code – a code that puts duty to the Corps above individual concerns. Behaviorally, Marines march together, drill together, and suffer together, and in doing so form an intense emotional bond among one another.

Marines are not born; they are made. In fact, for centuries militaries across the globe have been taking “hippies” and turning them into Marines. A mechanism key to this transformation is ritual.

What is ritual?

To answer this question, one must first begin by defining ritualized behavior. Ritualized behavior refers to attention-getting, stylized, invariantly sequenced, and often repetitious gestures or vocalizations designed to send social signals (for a more in-depth discussion see Rossano, 2012). Each of these qualities can be seen in the baboon “scrotum grasp ritual” used to cement male coalitions (Smuts & Watanabe, 1990; Whitham & Maestriperieri, 2003). Grabbing and ripping at the genitals is not uncommon when primates fight. Thus, the scrotum grasp is undoubtedly *attention-getting*. However, it is a *stylized* or more restricted form of the fighting act (i.e., a momentary grasp rather than aggressive grabbing and ripping). A stylized gesture can also be a more deliberate or exaggerated form of a gesture, such as a dramatic ball-room bow. The scrotum grasp also follows a fairly *strict sequence*: While making affiliative gestures such as lip-smacking and flattening of the ears, one baboon strides up to another using a rapid, straight-legged gait. The other responds in like fashion, and then after a quick hug each presents his hind-quarters to the other, often repeatedly (*repetitious*).

The terms “ritual” and “ritualized behavior” are frequently used interchangeably. There is, however, an important distinction. Ritualized behavior refers specifically to a stylized, attention-getting, invariantly sequenced, often repetitious social signal. Rituals are larger than this. They take ritualized behaviors and embed them within ceremonial, traditional, and symbolic elements, heightening their emotional impact and memorability (Bell, 1997). Mosque worship, for example, contains ritualized behaviors such as bowing and praying repeatedly, holding the palms upward, and touching the head to the ground. These behaviors, however, are surrounded by larger ceremonial and symbolic elements such as the design of the mosque, the dress of the worshipers, and the requirement of facing toward Mecca. While ritualized behaviors are common across the animal kingdom, ritual is uniquely human.

Ritualized behavior in the natural world

Ritualized behaviors are common across the animal kingdom, wherever important social signals must be effectively transmitted. For example, given their large size and aggressive nature, male elk (and other large male ungulates) usually elicit fear and avoidance among females. How then does a male get close enough for mating purposes? To signal amorous intentions, male elk use a “low stretch ritual” (Guthrie, 2005, p. 68). The stretch position emulates that of a calf wanting to nurse and puts the female at ease. Similarly, among many waterfowl, ritualized mating dances are used for both selecting mates and building social bonds between them (Kraaijeveld & Mulder, 2002). Finally, many dog owners are familiar with the “play bow

ritual” often seen at the opening of a rough-house play session. The dog lowers its head to the ground between its front paws with its hind end raised and tail wagging. The bow transmits the important message that seemingly aggressive acts (growling, chasing, biting, etc.) are intended as play, not genuinely aggressive.

As highly social creatures, our primate cousins have an array of ritualized behaviors for regulating their social lives. For example, chimpanzees, bonobos, and spider monkeys use ritualized embraces, kisses, pant-hoots, and grooming to re-affirm social bonds and reinforce the social hierarchy (Goodall, 1986). Gelada baboons use rhythmic back-and-forth approach vocalizations to signal benign intent during close-quarter feeding sessions. These vocalizations allow two baboons to peacefully feed near one another without threat (Richman, 1987). Finally, among chimpanzees, reconciliation between combatants is signaled by submissive bows, plaintive vocalizations, and the hand-out begging gesture (on the part of the loser) followed by embraces and kisses (from the winner, de Waal, 1990). Given their primate heritage, our ancestors were pre-adapted with a rich repertoire of ritualized behaviors for regulating social life.

Ritualized behaviors are purely indexical in their social function (Rappaport, 1999). This means that they signal or call attention to an organism’s immediate intentions or present state of mind. The dog performing the play bow is in a playful state of mind – he or she wants to play, not fight. The scrotum grasping baboon wants affiliation, not conflict. Human rituals are also indexical, but they frequently add a second, canonical function as well. The canonical function refers to the fact that rituals also reinforce and/or transmit important values. Muslim prayer reinforces a central value of Islam, submission to God’s will. Wedding ceremonies indicate the state of mind of the marrying couple – they are in love and desire to commit to one another. But by virtue of the ceremony’s traditional and symbolic elements (readings from sacred texts, exchanging of rings, lighting of candles, etc.), such values as the importance of fidelity and family are reinforced and transmitted to all in attendance. The value-laden symbolism of ritual combined with the deep evolutionary roots of ritualized behavior are probably why rituals often have such a powerful emotional impact on us.

Ritual synchrony

Group competition transformed our ancestors from “hippie-like” groups to “Marine-like” tribes. Very likely, a specific and frequent feature of ritual activity, synchronized movement, played a crucial role in this transformation. Rituals involving synchronized or coordinated movements, such as dancing, chanting, or singing together, are universal among humans and are extraordinarily powerful in creating group unity and commitment. It is all but impossible to find a traditional society that does not engage in frequent ritual singing, dancing, and chanting. For example, among the !Kung San, healing dances are held every two weeks (or so) and are considered vital to community spirit and wellbeing (Katz, 1982). The Hadza, traditional hunter-gatherers of eastern Africa, engage in hours-long *epeme* dancing on nights

with a new moon, but dancing often occurs on other nights as well and can erupt spontaneously when meat is brought back to camp (Marlowe, 2010). All human cultures engage in synchronized actions in the form of dance and music; and rituals and celebrations involving dance and song qualify as human universals (Blacking, 1973; Brown, 1991; Ehrenreich, 2008).

Synchrony is also common among nonhuman species. Examples include the (aforementioned) mating dances of waterfowl, the side-by-side swimming of sea horses, and the swimming and surfacing of dolphins and pilot whales (Connor, Smolker, & Bejder, 2006; Kraaijeveld & Mulder, 2002; Senigaglia, Stephanis, Verborgh, & Lusseau, 2012). Additionally, synchronized croaking (frogs), flashing (fireflies), appendage movements (fiddler crabs and kadydids), pant-hooting (chimpanzees), and vocal duetting (gibbons) have also been documented (Buck, 1988; Deputte, 1982, pp. 68–69; de Waal, 1988; Geissmann, 2000; Greenfield & Roizen, 1993; Mitani & Brandt, 1994). In experimental settings, parrots and sea lions have shown an ability to synchronize their motor movements to an external beat, and there are anecdotal accounts of horses synchronizing their gait to a musical beat (see Patel, 2014, for review and discussion). The universality of synchrony among humans combined with its frequency among nonhumans suggests deep evolutionary roots in our ancestral past.

Muscular bonding

Historian William McNeill (1995) was one of the first to describe how engaging in communal dancing, chanting, or marching produced a euphoric mental state leading to “muscular bonding” among participants. While marching into battle is a dubious military strategy, marching-as-group-bonding is highly effective.

The power of synchronized movement in creating social cohesion has been empirically demonstrated by Lakens (2010), who found that moving to a common rhythm created a sense of social unity exceeding that of other factors such as skin color. Other recent studies have found that synchrony can generate sentiments and emotions fostering unity. As people move together, they tend to like each other more, trust each other more, empathize more with each other, see each other as more similar, and are more willing to extend compassion and cooperation to each other (Hove & Risen, 2009; Lang et al., 2016; Valdesolo & DeSteno, 2011; Wiltermuth & Heath, 2009). For example, Wiltermuth and Heath (2009) found that moving together increased trust and cooperation. They had subjects either move in synchrony (walking in step, singing together, singing and moving together), move asynchronously (walking at individual paces, singing and moving individually), or not at all. Later, subjects played an economic game where they could extend varying levels of trust and cooperation to other players. Subjects who moved in synchrony were found to be significantly more trusting and cooperative than those who did not.

Later studies have found that moving together also enhances perceived similarity, empathy, and a sense of shared sacred values. These perceptions can, in turn,

motivate greater within-group altruism (Fischer, Callander, Reddish, & Bulbulia, 2013; Valdesolo & DeSteno, 2011). Synchrony's impact on perceived similarity even extends to a blurring of self-other boundaries. Paladino, Mazzurega, Pavani, and Schubert (2010) brushed a participant's cheek while the participant watched a video of a stranger's cheek also being brushed, either synchronously or asynchronously with their own. Compared to the asynchronous condition, synchronously brushed participants reported greater confusion regarding whether the stimulation was self- or other-experienced. They also claimed that the synchronously brushed face resembled their own more and that the person had more personality traits in common with them.

A key factor in the prosocial effects of synchrony is the shared emotional state that it creates. As people move in synchrony, their heart and breathing rhythms become entrained (Bernardi et al., 2001; Vickhoff et al., 2013), and their pain thresholds are heightened most likely due to the release of endogenous opiates (Cohen, Ejsmond-Frey, Knight, & Dunbar, 2010; Tarr, Launay, Cohen, & Dunbar, 2015). This mutual autonomic entrainment may even be present at the neuronal level (Wheatley, Kang, Parkinson, & Looser, 2012). These ANS effects facilitate empathetic identification, bringing people into a common positive emotional state leading to greater social connectedness (Pearce, Launay, & Dunbar, 2015; Fischer et al., 2014). The release of endogenous opiates very likely accounts for the euphoric mental state reported by McNeill (1995). Long ago, our ancestors discovered that if you want people to put the group and its values above those of individual self-interest, moving in synchrony cannot be beat.

Costly ritual

A notable quality of the dancing and singing of traditional societies is that it is often quite vigorous. The !Kung San, Australian Aborigines, Andaman Islanders, and Hazda are but a few of the many traditional people who engage in night-long sessions of energetic (sometimes frenetic) singing and dancing where "going to exhaustion" among some is not unheard of (Marlowe, 2010; Wade, 2009, pp. 107–114). Similarly, among Lau Fijians, ceremonial *Meke* dancing requires months of preparation including daily and sometimes twice daily practice sessions (Thompson, 1940, p. 76). Furthermore, in many traditional societies other ritual activities, such as initiation ceremonies, can be highly demanding, both physically and psychologically – so much so that anthropologist Harvey Whitehouse (1996) has referred to some as "rites of terror."

For example, female initiations among many traditional societies in southern Africa involve forced seclusion, bloodletting, genital cutting, and laborious training in ceremonial dances (Knight, Power, & Watts, 1995; Power, 1998, pp. 122–125). Beatings, deprivation, exhaustive physical exertion, exposure to harsh elements, genital mutilation, scarring, tooth removal, and forced dancing and chanting are among the rigors of many male initiation ceremonies among Australian Aborigines, Native Americans, New Guinea tribes, Pacific Islanders, and many African tribes (Catlin,

1867; Glucklich, 2001; McCauley, 2001; Whitehouse, 1996). Possibly the most dramatic of these initiations was the famous Mandan Indian Sun Dance ceremony where new warriors were suspended from the top beam of a large ceremonial enclosure with ropes attached to skewers embedded in their chests (Catlin, 1867). They might remain there for hours or days as dancing and chanting continued below.

Creating “Marine-like” cooperative groups entails more than just ritual activity – more than just singing, dancing, or marching together. It requires that these ritual activities exact a cost to the participants that ensures their honest commitment to the group. It requires not just ritual, but costly ritual.

Free-loading represents a threat to any cohesive group. Free-loaders feign commitment in order to reap the rewards of group life without contributing the effort necessary to maintain group stability. Weeding out free-loaders requires imposing ritual costs that serve as effective deterrents to uncommitted individuals. Lots of people like to sing and dance. That alone does not necessarily mean that when the chips are down they will put the group above themselves. Far fewer people will sing and dance *all night long*. Marine boot camp, two-a-day summer football practice, fraternity initiations, and other “hazing” type ordeals are modern analogues of costly ritual activity. The baboon “scrotum grasp” provides a good example of costly ritual in the animal world. The willingness to literally put one’s reproductive success into the hands of another is an act too risky for a “faker” to chance (Whitham & Macstripieri, 2003).

Supernatural motivation

Regardless of the potential benefits, any activity that entails pain, deprivation, psychological stress, and physical exhaustion is heavily disincentivized. So, what motivated our ancestors to engage in such activity? Psychological studies dating back to the time of James Mark Baldwin have consistently confirmed a fundamental fact regarding human behavior: We always behave better when watched. When people know their actions are under public scrutiny they adhere more assiduously to expected group standards and norms. This means being more honest, courteous, generous, reasonable, and (for males especially) courageous than when alone. Indeed, empirical studies have demonstrated exactly this (Andreoni & Petrie, 2004; Burnham & Hare, 2007; Rege & Telle, 2004; Rossano, 2007).

So powerful is the effect that the “public scrutiny” can be more imaginary than real and still have significant impacts on behavior. Significantly more prosocial behavior has been documented when only a picture of human eyes (Bateson, Nettle, & Roberts, 2006), a robot-image face (Burnham & Hare, 2007), and a suggestion of a nearby ghost (Bering, McLeod, & Shackelford, 2005) have been used as triggers of “social observation.” For humans, concern about public reputation is a powerful motivator when it comes to getting us to obey community standards. A central tenant of religious belief is supernatural monitoring, whether it be the omniscient God of present-day world religions or the natural and ancestral spirits of traditional religions. Supernatural monitoring has proven to be an effective means

of inducing “right behavior,” including participation in costly ritual activity (Shariff & Norenzayan, 2007). Religious communities have proven to be more enduring because community members more willingly engage in costly ritual activity relative to comparable secular communities (Sosis, 2004).

The supernatural advantage

The supernatural not only motivates people to engage in costly rituals, it enhances the power of those rituals. Supernaturally enhanced rituals have greater potential fitness benefits compared to “secular” rituals. For example, a meta-analysis comparing spiritual meditation to secular meditation found spiritual meditation more frequently resulted in health benefits such as lower blood pressure, reduced heart rate, and improved mental health (Alexander, Rainforth, & Gelderloos, 1991). Similarly, devotional prayer was more effective in reducing anxiety, anger, and muscle tension in Christian subjects compared to progressive relaxation training (Carlson, Baca-seta, & Simanton, 1988).

Wacholtz and Pargament (2005) compared the effects of spiritual and secular meditation on anxiety reduction, pain tolerance, and mood. Spiritual meditators focused on a religious phrase such as “God is love” or “God is peace,” while secular meditators used the alternative mantras of “I am happy” or “I am joyful.” In later tests, it was found that the spiritual meditators had higher pain tolerance (they were able to keep their hands in the near-freezing water twice as long) and they had lower anxiety and a more positive mood.

The supernatural advantage in pain tolerance was replicated in another study that subjected devout Catholics and nonbelievers to electric shock (Wiech et al., 2008). While shock was administered, subjects sequentially viewed either a religious image – *Vergine Annunciate* by Sassoferato (the Virgin Mary praying) – or a similar nonreligious image – *Lady with an Ermine* by Leonardo da Vinci. A significant increase in pain threshold was found exclusively for the Catholic subjects when viewing the religious image. In other words, when the Catholic subjects contemplated the image of the Virgin Mary they could endure higher levels of shock compared to when they contemplated the *Lady*. Furthermore, when viewing the Virgin Mary, they could endure more intense shock compared to the nonreligious subjects regardless of what picture they viewed. Differences between the religious and nonreligious subjects were also found at the brain level. When the Catholic subjects viewed the Virgin Mary, they showed increased activity in an area of the brain known to be involved in the evaluation and modulation of pain (the right ventrolateral prefrontal cortex, rVLPFC). Similar activation was not found for the nonreligious subjects. A recent review confirms that positive religious coping strategies aid people in dealing effectively with chronic pain (Dedeli & Kaptan, 2013).

Supernatural belief also plays an important role in placebo healing effects. A review study found that spirituality (defined as “concerned with the transcendent, addressing ultimate questions about life’s meaning with the assumption that there is more to life than what we can see or fully understand”) served as a predictor of

placebo effects (Kohls, Sauer, Offenbacher, & Giordano, 2011). In other words, the more spiritual one is and the more spiritual practices (e.g., ritual activity, prayer, meditation, etc.) one incorporates into one's life, the more susceptible one is to placebo healing, pain reduction, and successful pain management. Furthermore, brain areas and nervous system responses associated with spiritual experiences and practices overlap with those known to be involved in placebo effects. Religion's positive health effects are mental as well as physical. Supernatural beliefs are generally associated with lower levels of anxiety, depression, and other psychiatric symptoms such as agoraphobia, paranoid ideation, and somatization (Flannelly, 2017).

One might complain that many of the studies showing a supernatural advantage in health, healing, and pain tolerance have used religious subjects. While this is true, if hunter-gatherers are any indication, then in our ancestral past, nonreligious subjects would have been few and far between. The important point is that for those open to supernatural beliefs (which our ancestors almost certainly were), the inclusion of those beliefs in ritual activity would have enhanced the power of those rituals to bring about fitness-enhancing health and healing effects. Thus, supernatural ritual would not just have had group-level benefits, it would have provided individual-level benefits as well.

The emergence of costly rituals

Why *Homo sapiens* displaced all other hominins has been a point of debate and discussion for over a century. While evidence of significant cognitive differences between *Homo sapiens* and other hominins (e.g., Neanderthals) has diminished, important social differences have remained (for discussion see Rossano, 2015). Both archaeological evidence and genetic evidence indicate that *Homo sapiens* had larger, more complex and interconnected social groups compared to Neanderthals. This social difference may very well have been decisive when the two species encountered one another in Europe. Cohesive social groups are built with costly rituals. Archaeological evidence shows that *Homo sapiens* were engaging in costly rituals to far greater extent than Neanderthals.

Four types of archaeological evidence can be used as indices of ritual behavior: beads, red ochre, deep cave ventures, and burials. Rossano (2015) reviewed evidence in each of these categories and concluded that costly ritual activity was far more evident among *Homo sapiens* than Neanderthals.

Red ochre

Red ochre is a mineral pigment used extensively among traditional societies in ritual activity. Both *Homo sapiens* and Neanderthal sites show evidence of red ochre collection. Evidence of red ochre collection occurs earlier for *Homo sapiens*, with most sites being dated to around 100–150,000 ybp, while most Neanderthal sites are dated to around 50,000 ybp. Additionally, there are far more *Homo sapiens* sites with substantial amounts of pigment compared to Neanderthals. Of 14 well-documented

Neanderthal sites (see Rossano, 2015 Table 2), only two (14%) have amounts numbering over 100 pieces. By contrast, of 20 well-documented *Homo sapiens* sites (Table 1), 16 (80%) have amounts of 100 pieces or more, 7 of which (35%) have over a thousand pieces. Most well-documented Neanderthal sites (8 of 14 or 57%) have three pieces or fewer. Presently, there is no evidence of *Homo sapiens* sites with so little ochre. Collecting and processing ochre to make pigment for ritual activity take time, effort, and a certain degree of skill, all of which *Homo sapiens* were expending to a much greater degree than Neanderthals.

Beads

Beads are used extensively in traditional societies in ritual gift giving and as body decoration. They are also known to have been used by hominins in ritual burial. As with red ochre, the appearance of beads in *Homo sapiens*' archaeological record generally predates that of Neanderthals. A very recent study has dated three Neanderthal beads to over 115,000 ybp, making them the oldest beads to date (Hoffmann, Angelucci, Villaverde, Zapata, & Zilhao, 2018). This, however, is exceptional as all other finds are dated to around 50,000 ybp. Bead production for anatomically modern humans (AMH), however, traces back to around 100,000 ybp at both African and Levantine sites (Skhul, Qued Djebbana, Qafzeh, and Grotte des Pigeons).

At all Neanderthal sites, the number of beads is small (always less than 40 and often less than 10). The same is true at the oldest *Homo sapiens* sites, with the exception of Blombos Cave in South Africa (dated to around 75,000 ybp) with around 71 beads. Later *Homo sapiens* sites, however, have large numbers of beads. At sites such as Ksar' Akil, Ucagizli (in Asia Minor), Fumane Cave (Italy), Krems-Hundssteig (Austria), and Riparo Mochi (Italy) numbers of beads range from 128 to over a thousand. Beginning 75,000 years ago and intensifying at around 40,000 years ago, *Homo sapiens* were gathering and fashioning significantly more beads than Neanderthals. Even if only a portion of these were used in ritual activity, the amount of time, energy, and effort (i.e., cost) that *Homo sapiens* were expending far outstripped that of Neanderthals.

Caves

Venturing deep into caves for artistic, religious, or other potentially ritual purposes has been well-documented for *Homo sapiens* during the Upper Palaeolithic (40–10,000 ybp). These ventures were often risky and dangerous. For example, reaching the painted chambers at Montespan Cave required fording through frigid waters for more than a kilometer. Accessing Nerja Cave in Spain involved a steep climb up a sheer rock face. The painted shaft at Lascaux necessitated dropping 16 meters into pitch darkness presumably by rope; while the Salon Noir chamber at Niaux Cave required negotiating a 450-meter passage and 200-meter climb. The danger was compounded by the fact that those venturing into caves carried torches and

artistic supplies, and were frequently accompanied by (and therefore supervising and undoubtedly worrying about) children. Once in the cave, *Homo sapiens* often expended considerable time, energy, and resources in the deep cave chambers creating paintings or constructing ritual venues, such as the elaborate El Juyo “sanctuary” in northern Spain (Arias, 2009; Freeman & Gonzalez Echegaray, 1981). Thus, there is little question that Palaeolithic spelunking was often a costly endeavor.

Although the most well-known and arguably the most impressive ritual use of caves occurred during the later Upper Palaeolithic (Altamira, Lascaux, El Juyo, etc.), *Homo sapiens* started penetrating into caves well before this time. For example, the earliest evidence of the ritual use of caves is likely that of Rhino Cave in Botswana (southern Africa) dated to around 70,000 ybp. Though the cave is not deep, the surrounding boulders and high walls effectively block out any direct sunlight and make access difficult.

Inside the cave, there is a natural snake-like outcropping. The outcropping was intentionally modified to enhance its serpentine qualities. The snake-rock is not the only unusual aspect of Rhino Cave. The cave floor is littered with an unusually large number of burnt and broken tools. The tools were produced in the cave using carefully selected, colorful, non-local (“exotic”) raw materials. These raw materials were transported to the cave from distances ranging from 50 to several hundred kilometers. At the cave site, the raw materials were meticulously fashioned into tools, which were then intentionally broken, destroyed, and burned. From a practical standpoint, this behavior is odd and costly. Time, energy, and valuable material resources were exhausted for no clear utilitarian gain. But these are precisely the hallmarks of human ritual.

Neanderthals used caves as well, but they almost always remained near the cave entrance (Sandgathe et al., 2011, p. 219). There are only two reasonably well-documented instances of Neanderthals venturing more than 100 meters into caves (although the recent re-dating of remains in Ardales Cave in Spain may add a third). The first is Gorham’s cave in Gibraltar, where an etching dated to around 40,000 ybp was found. The second instance, Bruniquel Cave in southwestern France, is more impressive. About 200 meters deep in the cave, after a very tight crawl through a narrow passage, there is a small (approximately 14 m²) enclosed floor space that appears to be a ritual site. Stalagmites and stalactites have been broken off and formed into two circles on the cave floor. Evidence of a fire is present in the larger of the two circles. The scene has been dated to around 175,000 ybp, long before AMH were present in the region (Jaubert et al., 2015).

Even Bruniquel, however, falls short in terms of behavioral cost compared to *Homo sapiens*’ use of caves. A comparison of it to Rhino Cave highlights the differences. At Rhino Cave, very particular (colorful) raw materials were transported to the cave from tens and possibly hundreds of kilometers away, while the materials at Bruniquel were found in the cave (stalactites and stalagmites). At Rhino, both the materials brought to the cave and materials found in the cave (the natural outcropping) were worked at the site, whereas no materials were worked at Bruniquel. Once worked, a considerable amount of raw material was destroyed at Rhino, whereas

nothing comparable occurred at Bruniquel. If rituals were conducted at Rhino and Bruinquel Caves, both may have involved important religious and/or symbolic content for the participants and in that sense were qualitatively equivalent. However, in terms of behavioral cost, Rhino appears to have exacted more from its participants than Bruniquel. Rhino Cave is not unique regarding how *Homo sapiens* used caves. The magnificent painted murals of Lascaux, Chauvet, and numerous other sites testify to the fact that *Homo sapiens* frequently brought materials deep into caves and labored extensively with those materials.

Burials

The earliest true burials among AMH are found at Skhul and Qafzeh Caves in Israel, dated to sometime between 120,000 and 90,000 ybp. Somewhere between 12 and 16 burials are present across these two caves. Most of the burials are simple, involving little more than a body being placed in an excavated grave. A few, however, go beyond this, and include some potential grave goods such as animal bones, red ocher, and, in one case, large blocks lining the grave area and a block placed atop the body itself. A somewhat later burial (76,000 ybp) has been documented at Border Cave in southern Africa. Here, the partial skeleton of a 4- to 6-month-old infant (BC3) was found placed into a deliberately cut grave, 24 cm deep, 38 × 30 cm in size.

The emergence of inhumation can also be seen among Neanderthals. However, as was the case with beads and red ocher, it generally occurs later than with *Homo sapiens*. With the possible exception of burials at Tabun Cave and some burials at La Ferrassie, nearly all Neanderthal burials date to 70,000 ybp or later, with most occurring between 60,000 and 50,000 ybp.

Similar to AMH, Neanderthals sometimes left grave goods with the burials. Indeed, their frequency of doing so was greater than that of early AMH. Nearly 70% of Neanderthal burials have grave goods, while only four of ten (40%) early (Middle Palaeolithic) AMH burials do. In both cases, the grave goods are almost entirely made up of materials frequently found at the grave site such as lithics, bones, and rocks.

In the Upper Palaeolithic, however, the extent of elaboration at some *Homo sapiens* burials is dramatically amplified. The most famous of which is the Sungir burial (in Russia), where three bodies were found lavishly adorned with headbands, armbands, ankle bracelets, and necklaces laced with literally thousands of beads. In addition to this, ornamental weapons and other indisputable grave goods were interred with the bodies. It has been estimated that the hours of labor necessary for such a burial would have run into the tens of thousands. While nothing quite matches Sungir in degree, other similarly elaborate burials have been documented at Le Madeleine, Dolni Vestonice, Saint-Germain-la-Riviere, and the famous “Red Lady” burial at Paviland. There is simply nothing in the Neanderthal archaeological record that even approaches the elaboration of these burials

The evidence reviewed can be summarized as follows: Every potential archaeological marker of ritual behavior shows more intensive use by *Homo sapiens* compared to Neanderthals. Specifically:

- 1 *Pigments*: 16 *Homo sapiens* sites (80%) have pieces numbering from hundreds to over a thousand, compared to only 2 (14%) Neanderthal sites. Most Neanderthal sites have three pieces or fewer. Collecting and processing ocher takes time, energy, and effort, something *Homo sapiens* were expending in far greater quantity than Neanderthals.
- 2 *Beads*: With one exception (where 40 beads were found), at all Neanderthal sites the number of beads is less than 10. Not only are there more *Homo sapiens* sites where beads have been found, there are many where the amount of beads is in the hundreds to over a thousand.
- 3 *Caves*: At most, there are only three instances of Neanderthals venturing more than 100 meters into caves. There are scores of examples of *Homo sapiens* venturing 100 meters or more into caves. AMH's use of caves was more resource intensive compared to Neanderthals, and in time reached a point of frequency and risk never approached by Neanderthals.
- 4 *Burials*: While both Neanderthals and *Homo sapiens* buried some of their dead, nothing in the Neanderthal archaeological record approaches the degree of elaboration found at many *Homo sapiens* sites.

Both *Homo sapiens* and Neanderthals left evidence of ritual behavior. However, when we compare the time, energy, risks, and resources expended by the two, every indicator of ritual behavior shows that *Homo sapiens* were engaging in more costly ritual activity. Costly ritual binds communities. It may very well have been this crucial social difference that made the difference when the two species confronted one another in Europe tens of thousands of years ago.

Conclusion

Drop a lone human in the Amazonian rainforest, the frozen Siberian steppe, or the Negev Desert and survival is unlikely. Yet collectively, humans live in all these places and more. Our hyper-adaptability is a byproduct of our hyper-sociality. By cooperating in resource acquisition, territorial control, and knowledge transmission and preservation, we humans have spread globally, displacing all competitors in our wake, including other hominins.

The message of this chapter is that this was accomplished using the same mechanism that all species use to establish cooperative relationships and regulate social life: ritualized behaviors. The human difference is one of degree, not kind. We took ritual to extreme levels to create extreme forms of cooperation. We built cooperative communities using costly rituals. The “cost” of those rituals was “repaid” in two ways: (1) through well-organized, highly cohesive groups (“Marines”) that out-competed more “individualistic” ones (“hippies”), and (2) through individual health,

healing, and strengthening benefits that accrued to ritual practitioners. Supernatural belief both motivated ritual participation and magnified its benefits. When the last non-*sapiens* hominin died, the remaining void was filled by a tribal-minded, ritual-practicing, supernatural-believing human from which all of us have descended.

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19

THE ROLE OF EGALITARIANISM AND GENDER RITUAL IN THE EVOLUTION OF SYMBOLIC COGNITION

Camilla Power

Are there constraints on the social conditions that could have given rise to language and symbolic cognition? Language has emerged in no other species than humans, suggesting a profound obstacle to its evolution. If language is seen as an aspect of cognition, limitations can be expected in terms of computational capacity. But if it is seen it as fundamentally for communication, then the problems will be found in terms of social relationships. Below a certain threshold of cooperation and trust, no language or symbolic communication could evolve (Knight & Lewis, 2017a); this has been termed a “platform of trust” (Wacewicz, 2017).

In *Origins of Human Communication*, Tomasello describes a “whimpering chimpanzee child” searching for her mother. The other chimps will understand this, but if one does know where the mother is, “she will not tell the child” even though she could direct it: “her communicative motives simply do not include informing others of things helpfully” (Tomasello, 2008, p. 5). In these conditions, language is not a possibility. Viewing shared intentionality as the unique human characteristic underlying language, Tomasello (2006, p. 516) observes that other apes do not “get” communicative intentions, do not participate in joint attentional frames, and are not motivated to inform or to help. As he argues, asking why apes do not have language is the wrong question. Let’s begin with why they will not even point.

For Hrdy (2009, p. 38): “The desire to psychologically connect with others had to evolve *before* language. Only subsequently do the two sets of attributes coevolve.” Before human ancestors began to speak to each other, their hominin antecedents

had evolved differently from other apes in their “eagerness to share one another’s mental states and inner feelings.”

In this chapter, I argue that quite specific social conditions were prerequisite for the evolution of language- and symbol-ready hominins. One of the requirements differentiating our ancestors from other African apes was a switch to mainly female philopatry – females living with their relatives, rather than dispersing at sexual maturity – coevolving with an increasing tendency to egalitarianism. Without these conditions, typical human intersubjectivity is unlikely to have emerged (Hrdy, 2009). Female ancestors would also have been constrained in terms of energy available for the evolution of larger brain volumes (Isler & van Schaik, 2012; Opie & Power, 2008).

Whiten used the idea of Machiavellian intelligence to explain the evolution of the strong egalitarian tendency of hunter-gatherers. Whiten went on to describe “deep social mind” (Whiten, 1999; Whiten & Erdal, 2012) as critical to the adaptive success of evolving human hunter-gatherers. By this he understood three features as coevolving and interdependent: mutual mindreading, egalitarianism, and cumulative cultural transmission, these being prerequisite for language evolution.

This chapter focuses on the sexual strategies entailed in deep social mind. How did increasing egalitarianism affect males and potentially “feminize” male behavior for cooperative offspring care? How were male and female relations affected in the evolution of genus *Homo* and *Homo sapiens*? Deacon (1997) saw the key dilemma facing evolving humans as maintaining pair-bonds in ever more complex multifemale/multimale groups. In this view, symbolic communication – a “radical shift in communicative strategy” – was needed to represent contractual obligation within wider social groups. For social anthropologists (Durkheim, 1912; Knight & Lewis, 2017a; Rappaport, 1999), the only medium that can generate the symbolic domain of a collectively imagined virtual world is ritual. Shared intentionality expands to “we” intentionality (Searle, 1995) as ritual participants engage in collective “deceptions” (Knight, Power, & Watts, 1995).

What drove collective ritual performance among evolving humans? Following Deacon’s (1997) suggestion, I argue the underlying dynamic was one of sexual conflict in increasingly complex social groups. Earliest rituals emerged as a strategy of reverse gender dominance. To test this, I will examine evidence of gender ritual among African hunter-gatherers, and review the record of the earliest durable media in the archaeology of human origins: ochre pigments.

Intersubjectivity can only evolve given female philopatry

Intersubjectivity as probing willingness for mutual or two-way mind-reading is basic to the “ontogenetic revolution” (Tomasello & Rakoczy, 2003). This crucial initial step begins at around 9–12 months when a child understands others as intentional agents, beginning with gaze-following and sharing attention to external objects or events. From this point on children apprehend goal-directed behaviors, and start to coordinate with and communicate shared intentions, expecting adults to “tune in”

to them. This springboard enables children to start creatively using cultural artifacts and linguistic symbols. Selection for such regular interaction – joint attentional activity including “sharedness” involving self–other equivalence; perspective–shifting; and apprehension of normativity (Tomasello & Rakoczy, 2003) – is fundamental for the evolution of language.

The mechanism critical to joint attention is found in the design of our eyes. Humans alone from over 200 primate species have evolved eyes with an elongated shape and a bright white sclera background to a dark iris (Kobayashi & Kohshima, 2001). Known as “cooperative eyes” (Tomasello, Hare, Lehmann, & Call, 2007), they invite anyone we interact with to see easily what we are looking at. Our eyes are perfectly adapted for mutual mind–reading. Looking into each other’s eyes, asking “can you see what I see?” and “are you thinking what I am thinking?” is completely natural to us from an early age. Eyes of this kind support shared attention and cooperative mutualistic social interaction. By contrast, the dark–on–dark eyes of great apes obstruct intersubjectivity. This is as expected given the dominant–subordinate hierarchical structure of nonhuman primate social life.

In her landmark book *Mothers and Others* (2009), Hrdy offers the most convincing account of the evolution of intersubjectivity. The argument is straightforward. Babysitting belongs to all human societies, with mothers happy to hand over their offspring for others to look after temporarily. African hunter–gatherers are the major practitioners of this collective or cooperative childcare (Hewlett & Lamb, 2005), indicating that it was routine in our heritage. In stark contrast, great ape mothers – chimpanzees, bonobos, gorillas, and orangutans – simply will not let their babies go. Because of possible harm to their infants, they are hyperpossessive and protective, not daring to take the chance. The risk of infanticide for young apes is all too real, arising both from male–strategic sexual competition and from female–strategic competition over resources (Palombit, 2012).

Such hyperpossessiveness is characteristic of great apes. Monkeys behave differently, in many cases being prepared to leave a baby with a trusted relative (Hrdy, 2009; Key & Aiello, 1999). The key factor involved is exactly how closely related individuals are. Old World monkey mothers usually live with their female relatives, while great ape mothers rarely do. This means ape mothers have no one nearby whom they trust adequately (Hrdy, 2009).

If our foremothers overcame such a lack of trust, this indicates they must have been living close to female relatives, the most useful and reliable initially being a young mother’s own mother (Hrdy, 2009). This conforms to the “grandmother hypothesis” that has been used to explain our extraordinarily long postreproductive lifespans, and the evolution of menopause (Hawkes, O’Connell, Blurton Jones, Alvarez, & Charnov, 1998; Hawkes & Paine, 2006; Volland, Chasiotis, & Schiefenhövel, 2005). Childhood itself is a unique aspect of human life history that coevolved with grandmothering. Technically, childhood is defined as the period after an infant is weaned before the child has any permanent teeth (Bogin, 2006). During that time, children need help with finding a diet they can process, and grandmother can find food and prepare it for the child. In this way, mother’s mother would have a big

impact on child survival, while the mother could begin her next reproductive cycle. This has resulted in the special characteristic of “stacked” families among humans, where mothers have several dependent offspring at once (Hawkes & Paine, 2006). With no one to help, other great ape mothers need very long intervals between births (e.g., Smith, Austin, Hinde, Vogel, & Arora, 2017), breastfeeding until each offspring can become independent. Lacking childhood in the sense of a transition period of dependence on adults, juvenile apes have high mortality risk (Lee, 2011).

Hrdy explores the impact of multi-parental care in shaping the evolution of our species’ unique psychological nature. Although cooperative childcare may start with the mother–daughter relationship, bonding with grandchildren would quickly lead to flexible involvement of aunts, sisters, older daughters, and other trusted relatives. Precisely when an evolving hominin mother lets another take her baby off her hands, says Hrdy, selection pressures for two-way mind-reading and triadic structures for joint attention are set up. The mother must be socially adept to elicit support and judge motivations of the alloparent toward her offspring; the baby, once handed over, must be monitoring carefully “where’s mum gone?” at the same time as probing for signs about the intentions of the new carer; while the alloparent, necessarily a relative in the original scenario, adopts a quasi-maternal role. A whole array of behaviors sprang up to help this variegated triad of mum, baby, and allocarer to keep in contact: mutual gazing, babbling, kissfeeding. By contrast, hyperpossessive great ape mothers never needed such elaborate bonding mechanisms.

Investigation of the “cooperative breeding” hypothesis has shown that allomaternal care is the best predictor of unsolicited or proactive prosociality across primate species (Burkart et al., 2014). This supports Burkart, Hrdy, and van Schaik’s (2009) model of a combination of great ape cognitive capacity with cooperative breeding as fundamental to the evolution of genus *Homo*, in the early Pleistocene.

Hrdy’s cooperative breeding matrix not only provides the foundation for intersubjectivity but is also decisive in the expansion of brain size. According to Isler and Van Schaik (2012), great ape mothers, providing all the energetic requirements of their offspring alone, are constrained below a threshold brain volume of 6–700 cc – the “gray ceiling.” They note that extant great apes and extinct Australopithecine species converge on this limit to brain size, indicating these extinct taxa maintained essentially ape-like single mother lifestyles. This “makes the ‘escape’ from great-ape level brain sizes by *Homo* even more striking” (Isler & Van Schaik, 2012, pp. S463–S464). They propose that adoption of cooperative breeding allowed brain expansion in *H. erectus*.

Human ancestors broke through this ceiling some 1.5–2 million years ago with the emergence of large-bodied *Homo erectus*, with brains more than twice the volume of those of chimpanzees today. This suggests cooperative childcare was already part of *Homo erectus* society, with concomitant features of evolving cooperative eyes and emergent intersubjectivity. These aspects of our biology, life history, and evolved psychology – our intersubjectivity, our cooperative eyes, large brain size, and life history stages of grandmothering and childhood – could only have been favored in social conditions of greater egalitarianism and reduced tendency to dominance

hierarchy. Specifically human qualities of prosociality, social tolerance, and aversion to inequity on behalf of others, not just self (Burkart et al., 2009), fostered by cooperative childcare, would have launched the human career of cumulative cultural transmission (Van Schaik et al., 2012; Van Schaik & Burkart, 2011).

At the point in *Homo* evolution when female reproductive costs increased significantly, through both body and brain size increases (Key & Aiello, 1999), male involvement in the cooperative breeding system would have become critical. On the one hand, a process of male domestication could be expected as part of the evolution of intersubjectivity; on the other, significant levels of sexual conflict could arise from would-be dominant males. Out of these contradictory evolutionary dynamics, revolutionary transitions in communication emerged. It is notable that the truly novel male-female relationship emerging from a cooperative breeding context of stacked families is an increasingly longer-term brother-sister association. Domestication of male behavior in the cooperative breeding matrix may have evolved first by this pathway.

Deep social mind: cultural transmission needs egalitarianism

The most salient feature of our anatomy distinguishing us from other apes is the size of our brains. While human and chimpanzee mothers have a fairly similar body weight, adult humans today have upward of three times the brain volume of a chimp (Isler & van Schaik, 2012). This is an exceptional feat of energy provision in reproduction by human foremothers, because brain tissue is very energetically expensive (Aiello & Key, 2002; Aiello & Wheeler, 1995; Foley & Lee, 1991; Power & Aiello, 1997).

The level of egalitarianism in descendants of *Homo erectus* can be tracked by the size of brains in these early humans, using the fossil record. From around the beginning of the Middle Pleistocene (780,000 ybp), brain size increases with *Homo heidelbergensis* (or the last common ancestor of ourselves and Neanderthals; see Stringer, 2016: Figure 2c). The few African fossils from 800–600,000 ybp have cranial capacities in the range of 1,200–1,300 cc; that is, in the modern range, three times a chimpanzee volume. However, the steepest increase in cranial capacities occurs later – from ~300,000 ybp (e.g., de Miguel & Henneberg, 2001: Figure 1). African fossils suggest that this last phase coincided with our speciation (see Power, Sommer, & Watts, 2013, p. 42, Table 1; Watts, 2014). It also appears consequent on a suite of behavioral changes in the period ~500–300,000 ybp, incorporating regular fire use/camp fire social organization, new technologies in lithics, meat procurement, and shelter (Brooks et al., 2018; Watts, Chazan, & Wilkins, 2016).

If the fossil record reveals new sources of energy available to mothers, a key issue is what social strategies brought this about. Any tendency to male dominance, sexual competition, and strategic control of females (cf. Foley & Gamble, 2009) would have blocked these unprecedented increases of brain size. A male who mate-guarded one or more females continuously to ensure paternity would not be a productive hunter

because he could only move as fast as females and offspring. Those females might choose to mate with more successful provisioners willing to share high-quality foods. This would lead to critical sexual conflict between mate-guarding dominants and females needing food from investor males. While there must have been variability in the degree of dominance or egalitarianism among human groups, it is clear that those populations where male dominance, sexual conflict, and infanticide risks remained high were not the ancestors of modern humans. Instead, our forebears solved the problem of great ape male dominance, harnessing males into routine support of these extraordinarily large-brained offspring.

The Machiavellian intelligence or social brain hypothesis argues that the neocortex expanded as hominin groups and social networks became larger and more complex. Across monkeys and apes, neocortex volume, measured as size of neocortex relative to total brain size, relates specifically to female group size, and not male group size, suggesting that female social demands have driven the evolution of intelligence (Lindenfors, 2005). Coevolving with increased social complexity – and increased costs for mothers – was the capacity for tactical deception (Byrne & Corp, 2004) – and hence for manipulation of “fictions”; while dominant individuals were less and less able to maintain reproductive dominance against Machiavellian alliances (Pawlowski, Lowen, & Dunbar, 1998).

Erdal and Whiten (1994) saw that Machiavellian intelligence could be extended to explain the difference between primate-style dominance hierarchies and typical hunter-gatherer egalitarianism. At a certain point, the ability to operate within alliances will exceed the ability of any single individual, no matter how strong, to dominate others. If the dominant tries, he will meet an alliance in resistance who together can deal with him. Then, the sensible strategy becomes not to try to dominate others, but to use alliances to resist being dominated oneself. This was termed “counterdominance” by Erdal and Whiten (1994), and they used it to describe what is typically found in African hunter-gatherer societies – demand-sharing, humor as a leveling device, and the impossibility of coercion because no particular individual is in charge. They saw Machiavellian counterdominance as fundamental to the emergence of human psychology, with competing tendencies for individuals to try to get away with bigger shares where opportunity presents, but, faced with demands from others, to give in and settle for equal shares.

Developing the idea of counterdominance, Whiten and Erdal (2012) propose “deep social mind” – the coevolution of egalitarianism, culture, and mind-reading with language – in the emergence of a hunter-gatherer socio-cognitive niche. Deep social mind then incorporates the idea of intersubjectivity as central to human cultural cognition but inserts a necessary political dimension to this.

From an evolutionary perspective, equality in reproductive fitness is most significant. Without concomitant reduction of reproductive variance, counterdominance could not be a stable strategy. Pawlowski and colleagues (1998, p. 361, Fig.1) show that increasing Machiavellian intelligence in monkeys and apes does indeed result in reproductive counterdominance. Bowles (2006) points to reproductive leveling among predominantly monogamous hunter-gatherers as critical to egalitarianism.

Whiten and Erdal note the general hunter-gatherer tendency for monogamy, or serial monogamy, which contrasts with polygyny among propertied farmers and herders. Again, our biology shows the underlying features of reproductive physiology that led to reproductive egalitarianism.

Women have evolved a sexual physiology that can be described as leveling and time-wasting. Why? Because if a hominin female needs extra energy for her hungry offspring, better to give reproductive rewards to males who will invest in those offspring. Our reproductive signals do not favor males who want to identify fertile females, monopolize the fertile moment, and then move on to the next one (a classic strategy for dominant male apes). Women have concealed and unpredictable ovulation; while the length of the luteal (or post-ovulation) phase of the cycle is fairly constant, the follicular phase leading up to ovulation is more variable, making it hard for males to track. Women are also sexually receptive, potentially, for virtually all of their cycle, a much larger proportion than any other primate (Gangestad & Thornhill, 2008). The combined effect is to scramble the information for males about exactly when a female is actually fertile.

From the viewpoint of a dominant male guarding a harem of females this wastes his time. While he is guessing about the possible fertility of one cycling female, he has to stay with her, and is missing all the other opportunities. Meanwhile, other males will be attending to those other sexually receptive females. Continuous sexual receptivity spreads the reproductive opportunities around many males, and hence is leveling from an evolutionary perspective. BaYaka women of the Congo forest express their resistance to male philandering with the slogan: “One woman, one penis!” (Knight & Lewis, 2017a, p. 440). This is their ritual rallying cry against male attempts to form a harem. Hunter-gatherer women demand one man each to support their energy requirements and investment in costly offspring.

If cooperative breeding is initially based on intergenerational cooperation between females, how do males fit in? Opie and Power (2008) argue that grandmother support, by reducing the mother’s interbirth intervals, would significantly promote mating effort by males, because a mother with a supportive mother will herself be fertile sooner. Male support to a mother who enjoys her own mother’s support will help reduce infant mortality. According to life history theory, such reduction in mortality allows selection for longer lifespans with delayed sexual maturity, as is found in *Homo* compared with *Pan*. Following grandmothers, older siblings – sisters and also brothers – may become key allocarers (Kramer & Otárola-Castillo, 2015). Longer-term sister-brother relationships – not found in great apes – would be facilitated by the delay in onset of reproduction.

This combination of female (and male) kin support with male mating effort could provide the cooperative breeding framework for the early Pleistocene, accounting for female costs in the first major body/brain size increase. Male mating effort could be supportive in a multimale/multifemale context, with increased hominin group sizes, without necessarily implying exclusive pair-bonds. A strategy whereby mothers mate with more than one male, with probabilistic chances of paternity, could bring extra investment and insurance against infanticide risk, if any one mate

deserted. Large neocortices characterize monogamous species in mammals and birds, whether or not biparental care is involved (Schulz & Dunbar, 2007). Dunbar (2010, p. 165) suggests that the evolution of pair-bonding “is dependent on having a large brain to manage the relationships involved, rather than pair-bonding having evolved to facilitate the rearing of large-brained offspring.” Human pair-bonding then is an outcome of having the kin-based cooperative breeding network in place to support larger-brained offspring.

The accelerated encephalization in our African ancestors from 700,000 ybp, and later in *Homo sapiens* from 300,000 ybp, suggests a runaway feedback process of selection for social intelligence (Whiten & van Schaik, 2007). What was exercising our ancestors’ Machiavellian, hypersocial, and intersubjective intelligence so much during this time period? Solving Deacon’s dilemma, securing reliable male investment against a background of increasingly large group networks – hence greater opportunities of finding other fertile mates – in the Middle to Late Pleistocene could be a contributing factor to this feedback loop (Dunbar, 2010). This increase in brain size, especially in the period of modern human evolution c. 300–150,000 ybp, is predicted to correlate with increased ability to manipulate fictions; an increased life-history period given to play and social learning; and egalitarianism based in reproductive leveling. This all depends on, and must coevolve with, females defraying their increasing reproductive costs through cooperative breeding strategies.

Reverse dominance: the coalition of everyone

These then are key constraints in the social contexts of late archaic to early modern *Homo sapiens* as brain sizes increased between 300,000 and 150,000 ybp:

- a Mothers, daughters, and other female kin tended to stay together, for the sake of allocare.
- b Increasing egalitarianism produced reproductive leveling among males, asserted against any would-be dominant male.
- c Females needed increased levels of investment from male hunters to alleviate increasing reproductive costs.

Boehm (2000, p. 212) argues that “our forebears became egalitarian only after they were able to moralistically outlaw alpha male behaviour.” Boehm points out that primate coalitions come in two kinds, those aimed at maintaining dominance and those aimed at resisting it. Only the latter has the potential to recruit new members indefinitely, to the point where it finally embraces everyone. Boehm argues such an outcome is not realistic for nonhuman primates, whose coalitions remain transactional, sectional, and limited. For humans, however, something entirely different happened. Primate dominance was turned upside down as former subordinates succeeded in establishing collective dominance over would-be alpha males. For Boehm, resistance to dominance was mounted so consistently and successfully that it culminated in

what he terms “reverse dominance” – dominance exercised by the community as a whole. Establishing for the first time the idea of a moral community, this was not just an evolutionary development but a revolutionary one.

When Whiten and Erdal (2012) relate egalitarianism as counterdominance to the ratchet effect or cumulative cultural transmission, they do not distinguish cultural transmission of learned behavior – found in limited degrees among all primates – from the cultural transmission of symbols, which is unique to humans. An advantage of Boehm’s model is that it can explain how community-wide adherence to moral norms was established by means of *symbolic* cultural mechanisms (cf. Chase, 1999; Tomasello, Melis, Tennie, Wyman, & Herrmann, 2012). Boehm’s model provides a valuable point of departure if it can be developed to produce testable predictions. As it stands, we are left wondering why humans so tenaciously resisted being dominated. What motivated these rebel strategies to be repeated and become patterns of behavior?

Reverse dominant ritual generates symbolic culture

As brain sizes increased, mothers needed more regular and reliable contributions from male partners. In African hunter-gatherers this has become a default pattern known as bride service. Typically found among African and other immediate-return foragers, in bride-service societies male sexual access depends on success in provisioning (Collier & Rosaldo, 1981; Lee, 1979; Woodburn, 1968). Bride service associates strongly with a tendency to matrilineal residence, especially among African hunter-gatherers (Marlowe, 2004; Thomas, 2006; Woodburn, 1968). Support of a woman’s kin obliges hunters to surrender whatever game they catch to the bride’s family. This is an effective mechanism of redistribution, making it hard for men to assert control through food distribution (contra Foley & Gamble, 2009).

The problem for early modern human females as they came under the maximum stress of increased brain size would be males who tried to get away with sex without bride service. To deal with this threat, mothers of costly offspring needed to extend their alliances to include everyone against any potential alpha male. Related men (brothers or mother’s brothers) would be supportive of those females. In addition, men who were willing investors in offspring would have interests directly opposed to the would-be alpha, who undermined their reproductive efforts. This results in Boehm’s whole community as a coalition against a would-be dominant individual. The Machiavellian coalition most likely to be mobilized would be females with kin who shared interest in outcomes with investor males.

So, the occasion for reverse dominant collective – *moral* – action happened whenever a prospective alpha male tried to abduct a potentially fertile female. One model for the emergence of symbolism fits this reverse dominance dynamic and makes specific predictions about the signaling that would arise: the Female Cosmetic Coalitions (FCC) model (Power & Aiello, 1997; Power, 2009; Power et al., 2013).

The alpha male strategy is to find and mate with a fertile female, before moving on to the next one. But how does a male identify fertile females, considering that in human evolution ovulation became progressively concealed? One cue to the human reproductive cycle could not be so easily hidden: menstruation. With oestrus phased out during human evolution, menstruation became a highly salient cue to males of a female near fertility.

A dominant male strategy could evolve to target and guard menstrual females, monopolizing matings until each female had ceased to cycle and was pregnant. Then he would look for the next one. In nomadic hunter-gatherer camps, women of reproductive age are pregnant or nursing much of the time, making menstruation relatively rare. From the standpoint of female coalitions forged to secure cooperative childcare and provisioning, if males fight over an imminently fertile, menstrual female they will be unreliable carers and providers. Menstruation also triggers potential conflict and competition among females, because a pregnant or nursing mother risks losing male support to a cycling female.

Non-cycling females can respond in two ways to this dilemma. Following the logic of concealed ovulation, they might try to hide the menstruant's condition so that males would not know. But because the signal has potential economic value by attracting male attention, rather than hiding it, females should do the opposite: make a big display out of it (Knight et al., 1995; Power, 2009). Whenever a coalition member menstruated, the whole coalition should join in amplifying the signal to attract males and their labor to the coalition. Females within coalitions will begin to use blood-colored substances as cosmetics to augment their signals.

In creating a cosmetic coalition in resistance, females deter alpha males by surrounding a menstrual female and refusing to let anyone near. But even as a negative, this cosmetic display encourages investor males who are willing to hunt for the whole female coalition. Those cosmetically decorated females who show solidarity against an alpha male ensure that investor males get the fitness rewards. Investor males should sexually select females belonging to ritual cosmetic coalitions, because they then have no competition from would-be alphas.

The FCC model, with non-cycling females aiming to obstruct and control sexual access to cycling females, offers a prototype "moral" strategy – a basis for the emergence of the puberty rituals, taboos, and prohibitions that surround menstruation in so many ethnographic accounts (Knight, 1991; Testart, 1986). It also yields a prototype symbolic strategy, with collective or normative agreement that fake "blood" stands for real blood. While it is revolutionary at the level of morality, symbolism, and economics, the strategy emerges as an evolutionary adaptation, ultimately driven by male sexual selection of female ritual participants. On this basis, through reverse gender dominance, the hunter-gatherer institution of bride service emerges, with roughly egalitarian chances of reproductive success for all hunters.

The process of sexual selection whereby choosy investing males discriminate as to which female to invest in will involve ritualized display by coalitions of related females – the reverse of the usual sexual selection dynamic in mammals and birds

(Power, 2009). For the first time in evolution, such a sexually selected display will reference a collectively imagined construct, the presence of “blood,” “fertility,” or “potency” signaled by red cosmetics. The dynamic of collective resistance to would-be male dominance will generate metaphoric elaboration, resulting in ritually performed inversions of reality, generating a fully symbolic cosmology.

Where ritual coalitionary displays occur only on occasion when a local female menstruates, these signals, however elaborated, remain indexical (in the Peircian typology of signs), that is, intrinsically linked to perceptible reality. But it is easy to see how a female coalition would be pushed into regularly signaling shared “fictions.” Suppose some males attracted by cosmetic displays are reluctant to leave for hunting. If they try instead to mate-guard imminently fertile females, then female coalitions drawing on male kin support would have to respond with louder, clearer signals of resistance.

Knight and colleagues (1995, p. 84) argue that the way female coalitions would construct their “No” signal is by reversing the settings of the species mate-recognition system. Where female animals in courtship normally display “right species/right sex/right time,” systematic reversal by a defiant female coalition yields “wrong species” – we are animals, not humans; “wrong sex” – we are males, not females; and “wrong time” – we are not fertile right now (but soon we will be). The predicted signature of ritual power turns the world of brute reality upside down, establishing an inviolable taboo, or sacred state of menstrual or body-painted females. Transmission of such signals counter to perceptible reality and counter to normal relations of dominance would require energetically expensive, repetitive, iconographic pantomime – high-cost ritual signals sustaining supernatural fictions (Durkheim, 1912).

Knight and Lewis (2017b) draw on Durkheim’s observation that human conceptual thought is metaphorical. To think creatively, they state, “is to discern truth on a deeper level by means of metaphors – expressions which, interpreted literally, are patent falsehoods” (2017b, p. 86). They propose the “world’s first metaphor” – women’s pantomime of game animals while “bleeding.” This cascades into a variety of conceptual equivalences between women’s reproduction and men’s hunting, typically found in African and other hunter-gatherer cosmologies. Wrong sex/wrong species ritual performance “is on one level pure nonsense. But escaping the confines of literal truth is precisely the secret of symbolism. Saying one thing in order to mean another is the essence not only of metaphor but of all symbolic language and life” (2017b, p. 95). As a Machiavellian *and* intersubjective coalition, the females (with their offspring and male kin) are playing a collective trick that they are the game animals they want men to hunt. Under conditions of reverse dominance, Machiavellian and intersubjective men will get the message and play along with the shared fiction. Just as Machiavellian intelligence, taken to its extreme, becomes counterdominant egalitarianism, so the Machiavellian capacity of manipulation of fictions will ultimately produce playful mutual engagement in shared deceptions. By contrast, Machiavellian apes, under pressure of competition for dominance, have no time to waste entertaining any such fictions.

Ritual as costly signals of commitment: ritual/speech coevolution

Using symbols and speaking language could only have emerged on the basis of a platform of trust afforded by egalitarianism. Comparing nonhuman primates with hunter-gatherers, Sahlins (1960, p. 83) noted egalitarianism as one crucial difference, and saw culture as “the oldest ‘equalizer.’ Among animals capable of symbolic communication,” he said, “the weak can collectively connive to overthrow the strong.” But the arrow of causality can be reversed. Because among Machiavellian, counter-dominant, and intersubjective humans weaker individuals can connive to overthrow the strong, humans are animals capable of symbolic communication.

Only in such conditions is language likely to emerge. Language as the mutual exploration of each other’s minds relies on the ultimate in intersubjective negotiation and ability to look through the eyes of the other. A fundamentally egalitarian matrix is the only possible ground for the evolution of language.

As the framework for studying animal communication, signaling theory offers a powerful conceptual tool for anthropologists, archaeologists, and others investigating the evolutionary emergence of symbolic culture (Bliege Bird & Smith, 2005). Signal evolution theory deals with the emergence, function, and design of animal signals. Central debates have concerned honesty and reliability of signals (Zahavi & Zahavi, 1997), manipulation and mind-reading (Krebs & Dawkins, 1984), and effects of shared versus conflicting interest in outcomes (Maynard Smith & Harper, 2003).

Evolutionary ecologists such as Richard Sosis (2003) and colleagues have conducted empirical work demonstrating the adaptive design of high-cost ritual for increasing cooperation and guarding against freeriders. In ritual, individuals clearly demonstrate to one another their willingness to take on high costs, with hard-to-fake emotional engagement. To gain entry to the group or coalition, any initiate must take on the costs and show the authentic emotional response. This powerfully deters would-be defectors or freeriders. Through mechanisms of singing, dancing, and visual display, as well as shared pain and hardship, ritual is shown to increase levels of cooperation among unrelated group members.

Kuhn (2014) proposes a signal cost analysis of the broad record of earliest signaling media from the African Middle Stone Age (MSA) and Eurasian Middle Palaeolithic. In his account, the evidence comprises fundamentally pigments from c. 300,000 ybp, with beads beginning to occur only in the past 100,000 years. Beads remain rare, alongside examples of geometric engravings with continued pigment use, until 45–40,000 ybp, when the bead record becomes more elaborate, diverse, and abundant. Kuhn argues that beads, especially when found in massed quantity, were more costly signals than earlier pigments, and that they were being deployed in contexts of greater scale and complexity in social interactions, implying more competitive and differentiated social groups and interests. The earliest signaling traditions, then, occurred among more egalitarian groups. But Kuhn has no explanation for why signaling began, when it began, or why it took the form of red pigments.

Rossano (2015, and see this volume) also examines the Middle/Late Pleistocene archaeological record to detect the signature of increasingly costly ritual, comparing

closely through time the traces of ritual in our African ancestors and Eurasian Neanderthal lineages. He observes a watershed 150,000 years ago associated with modern humans of increased ritual costs, arguing that this was driven by two factors: (a) climatic and resource stress causing migration and greater interaction of populations; and (b) reproductive conflict over reliable pair-bond support for increasingly large-brained offspring. Increase in Neanderthal ritual costs comes later and with less intensity than for *Homo sapiens*.

Rossano draws on the original Female Cosmetic Coalitions model of Knight et al. (1995), who pioneered the application of signal evolution theory to MSA archaeology. Knight's "ritual/speech coevolution" hypothesis focuses on the interactions of high-cost ritual and low-cost linguistic signals with particular reference to the ocher record in the African MSA. Regular ritual performance – song, dance, cosmetic display – among early modern humans provided the matrix of rule-governed and prosocial behavior within which a speech community based on trust could emerge (Knight, 1998). The spread of ritual across communities would facilitate cooperation between strangers – the widespread prosocial behavior prerequisite for language.

Signal evolution theory contrasts two divergent trajectories depending on the degree to which signaler and receiver share interest in the same outcomes. High-cost, repetitive, multimedia displays suggest a function of social manipulation, conflict, and exploitation. Resistance by receivers sets up selection pressures acting on signal design. Signalers who encounter "sales resistance" are driven to respond by repeating signals, increasing amplitude, and resorting to costly multimedia displays. Such extravagant advertisers include peacocks displaying to would-be mates or caribou bulls bellowing in the rut. Zahavi (1987) shows how the discernible costs of such displays enhance their credibility by testing the very reservoirs of quality that signalers are attempting to advertise. The evolution of high-cost signaling is driven by skeptical receivers pushing signalers to ever greater competitive effort to prove their quality.

By contrast, low-cost, quiet, and efficient signals indicate a cooperative audience. If signalers can afford to cut their emission costs, it is only because listeners are investing corresponding effort in receiving, decoding, and acting on signals. This implies that signalers and receivers significantly share interests. For such "conspiratorial whispering" (Krebs & Dawkins, 1984) to evolve, signalers must be imparting useful information to receivers, and those receivers are not expecting to be deceived.

Turning to human symbolic communication, Knight (1998) argues that our ancestors developed divergent, formally contrastive types of communication along these two "high-cost" and "low-cost" trajectories: ritual and speech. On the basis of signal evolution theory, it appears that speech emerged in a cooperative context, while ritual did not. For speech to have evolved, "conspiratorial whispering" in the human case must have been anomalously trusting. By contrast, ritual, with its costly, inefficient features of redundancy and display, emerged from a dynamic of conflict, manipulation, and exploitation.

The paradox here is that the extremely low-cost, conventional codes of speech leave listeners vulnerable to deception. With no intrinsic link between sounds and their purely arbitrary meanings, words are routinely decoupled from emotional veracity or real-world stimuli. Despite speech having no intrinsic reliability, human conversation works on Grice's "cooperative principle" (1969), with participants, even where they may be in some degree of social conflict, cooperating at the level of mutual conversational ends. If humans are on "speaking terms," they expect intentional honesty. Somehow this new default of honesty – honesty in the deployment of volitional, conventional signals – became established.

This paradox can be unraveled when considering that, whereas speech is fundamentally interpersonal, ritual operates group-on-group, and may function to demarcate boundaries of those groups. Experience of the high-cost, multimedia signals involved in ritual will differ according to whether the receiver is outside or inside the performing group. For outsiders, the costly signals are manipulative and exploitative, needing to overcome "sales-resistance" by impressing observers with the quality of performance. Among insiders, the collective effervescence (Durkheim, 1912) aroused by singing, dancing, and making music together will intensify in-group trust and generate a sense of group identity as "We" (Rappaport, 1999). Focusing on the emotional responses of individuals to ritual experience, Alcorta and Sosis (2005) show that the very costliness of undergoing ritual enables those individuals to demonstrate in hard-to-fake terms their commitment to the group.

There are two major emergent effects from such proto-ritual experience. First, the novel levels of in-group trust can now permit conventionalization and shorthand reference – volitional, conventional signals – in communicating among group members, now on the way to becoming a speech community. Second, in representing their coherent and enduring solidarity, ritual performers generate sacred, supernatural, and counter-intuitive concepts – the first gods (Alcorta & Sosis, 2005; Durkheim, 1912; Knight et al., 1995; Rappaport, 1999).

Testing the model

There are two main areas where the FCC model offers predictions: first, against the archaeological record of the Middle Stone Age; second, in relation to hunter-gatherer ethnography of social organization, gender relations, and ritual cosmology (see Power, 2009 for full overview of predictions).

Archaeology

The FCC model clearly predicts that the world's first symbolic media will comprise an industry of blood-red cosmetics, remnants of a ritual bodypaint tradition. Because the strategy was meant to motivate males to hunt and bring back provisions to help mothers feed large-brained babies, the earliest use of cosmetics should coincide with significant increases in brain size (Power et al., 2013). This points to earliest use of pigments from c. 700,000 ybp and especially correlating with encephalization

occurring from c. 300,000 ybp (de Miguel & Henneberg, 2001). Close correlation is predicted between reverse gender dominance, reproductive egalitarianism, and the maximization of brain sizes in early modern humans, suggesting ritual traditions would be established by c. 250–150,000 ybp.

Before 100,000 ybp, the only repeated material cultural evidence of signaling behaviors in the *Homo* lineage is the record of earth pigment use (Brooks et al., 2018; Kuhn, 2014; Watts et al., 2016). This substantially comprises blood-red iron oxides – ochre – in both African and, more sporadically, Eurasian lineages (see Power et al., 2013; Watts, 2014; Watts et al., 2016 for review). Current dating of the oldest pigments falls into the Fauresmith, in the period ~500–300,000 ybp (Watts et al., 2016), and the earliest Kenyan MSA, at ~320–295,000 ybp (Brooks et al., 2018). Both southern and eastern African examples indicate long-distance transport of materials, increasing costliness of the associated activities (contra Kuhn, 2014).

Once it begins, ochre use appears consistent and continuous. This contrasts with later symbolic traditions that seem to appear, then disappear, only to reappear in the Late Pleistocene (Shea, 2011). Already a continuous and ubiquitous tradition in southern African rockshelter campsites from at minimum ~110,000 ybp (Knight et al., 1995), this conservative estimate for a regular, ubiquitous tradition (Watts, 2014) extends further back in time, in the light of redating of the sequence at Border Cave (Grün & Beaumont, 2001) and findings from Pinnacle Point 13B (Marean et al., 2007). Over a half-million years, pigment use may exemplify a unidirectional, cumulative cultural tradition, changing from no use to irregular, then regular use, becoming continuous and ubiquitous about 200–150,000 ybp – the time of our speciation. Consistent presence of red ochre appears as a diagnostic cultural marker of our species. Eurasian lineages used ochre, and from relatively early dates (~250,000 ybp), but only much later and in certain places, if at all, did it become continuous (Watts, 2014).

Hunter-gatherer ethnography

African hunter-gatherers show a consistent assertive egalitarianism (Woodburn, 2005), probably a very stable feature of social life reaching back into evolutionary time (Power, 2017). The default among African foraging groups is bride service, initially matrilineal (e.g., Lee, 1979; Marshall, 1959, for Ju/'hoansi; Lewis, 2002, for Western Pygmy Yaka; Woodburn, 1968, for Hadza). To perform bride service, a son-in-law lives for several years with his wife and her parents; his wife's first and perhaps second child is likely to be born where her mother lives. Population genetics studies reveal a distinct matrilineal bias, evident in the localization of mother-to-daughter mtDNA lineages compared to father-to-son Y-lineages. This is opposite to the pattern in neighboring farming and pastoralist populations (Schlebusch, 2010, for Khoesan; Verdu & Austerlitz, 2015, for Central African Pygmies). A similar tendency for female relatives to stay together is found in Hadza longitudinal residence data (Blurton Jones, Hawkes, & O'Connell, 2005; Wood & Marlowe, 2011; Woodburn, 1968).

The ethnography of immediate-return African hunter-gatherers, including Khoesan, Pygmies, and Hadza, is rich with examples of women defying potentially dominant males by forming intergenerational ritual coalitions. These engender intense female solidarity and are so successful that they go beyond defense against harassment to actively motivating male commitment and provisioning (Bombjaková, 2018; Finnegan, 2013; Knight, 1991; Lewis, 2002, 2008; Power & Watts, 1997).

When hunter-gatherer women mobilize their community, their reverse dominance performances have an underlying logic of applying leverage by temporarily withdrawing from sex. To achieve this, their body language must actively disrupt sex presently while motivating men with the prospect of future reward. The FCC model predicts the symbolic motifs for reverse gender dominance are “wrong species/wrong sex” primarily in association with menstruation.

A girl's first menstruation ritual among various northern, central, and southern Khoesan groups, known as the Eland Bull dance, is so widespread that it is likely to be very ancient (Lewis-Williams, 1981; Power & Watts, 1997). The girl herself is conceived as constantly transforming, changing her identity from female to male, human to animal (Keeney & Keeney, 2013), and the ritual observances, including sharing of hematite (a form of red ochre), must control and distribute this potency (Power & Watts, 1997). Metamorphosed into the Eland Bull, while under stringent taboos and seclusion, the girl is now clearly unavailable to any man – she is of the wrong sex, species, and time. The women's community celebrates and joins with her in signaling that, for the moment, they are not available for sex with their human husbands. Instead, they dance around the metamorphosing girl, playfully mimicking the behavior of mating elands.

Among the East African Hadza, the girls' initiation ritual *Maitoko* involves similar sexual defiance (Power, 2015). While bleeding, initiates reenact a myth about an ancestral matriarch who dons a zebra's penis – clearly “wrong sex” and “wrong species.” Dressed as hunters and armed with sticks, the *Maitoko* initiates a chase of young men in a dramatic reversal of gender roles.

In the Central African forests, gender reversal plays a key role in maintaining gender egalitarianism. Among the Mbuti in the east, the girls' initiation *Elima* involves girls becoming “hunters” and chasing young men with sticks in a manner extremely similar to the Hadza (Turnbull, 1960). Among the Yaka Pygmies of the Western Congo Basin, women-led reverse dominance is part of the fabric of life. Women periodically stage *Ngoku*, during which they dominate and control the camp. Conceptualized as women's communal spirit, *Ngoku* acts out the mythic theme of a primordial time when women lived without men (Lewis, 2002).

The message “wrong sex” is seen in women's mimicry of aggressive male postures and imitation of male ineptitude during sexual intercourse. “Wrong species” is heard in the women's polyphonic singing, conceived as the sounds of animals and forest spirits. “Wrong time” is implied in that any male sexual advances during a performance would be mercilessly mocked and impossible since all pubescent girls and women are participants. In this case the association with menstruation is less direct. A girl is referred to as *ekila* from the moment she first begins to menstruate.

The concept of *ekila* has multiple meanings, focused around the potency of different types of blood and the need to keep them separate: This generates the logic implicit in the sexual division of labor that keeps the blood men shed in the hunt from that shed by women making children (Lewis, 2008). *Ngoku* specifically teaches young women how to use sexual attraction to control men. It is accomplished by acting together in solidarity with other women, inhibiting males from the use of physical force and exerting leverage by periodically withdrawing sex while simultaneously arousing desire. The outcome of this display of women's potential for reverse dominance is the achievement of a strong measure of gender egalitarianism persisting beyond the ritual performance (Lewis, 2014).

Conclusion

In this chapter I have argued that the evolution of human symbolic cognition relied on a foundation of certain social conditions. Contrary to traditional assumptions about male kin-bonding and patrilocality as standard for human evolution (e.g., Foley & Gamble, 2009), what distinguished humans from other great apes was a tendency for females to stay with relatives, so that genus *Homo* mothers could get help from others (Hrdy, 2009). These features of human biology, life history, and evolved psychology offer evidence of an egalitarian past during evolution: large brain size; cooperative eyes; menopause and childhood; intersubjectivity and Machiavellian, nonsubmissive psychology. Women's evolved sexual physiology produced greater equality of reproductive opportunities among men, compared with great ape cousins, and underpinned the egalitarian tendency by reducing reproductive variance.

The key social and economic problem for mothers during the late phase of encephalization in late Middle Pleistocene humans was securing reliable male investment as social networks expanded. Symbolic communication arose out of ritualized displays by female cosmetic coalitions as they reversed dominance and resisted attempts by would-be alpha males to sequester imminently fertile (menstruating) females. Males who were willing investors chose females who were supported by cosmetic coalitions, because competition from alpha males was eliminated. Revolutionary and radical shifts in communicative strategies were in this way driven by evolutionary forces of sexual selection. The FCC model can account for the record of red pigments prevalent in the African MSA. It also predicts the template for gender rituals among African hunter-gatherers still being danced to this day.

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NORMS AND THEIR EVOLUTION

Kim Sterelny

Introduction

Humans have two very distinctive characteristics. First, we are cooperative in extraordinary ways. Our cooperation is unusual in its scope (for we do little of consequence alone); in its demographic complexity and scale (we do not cooperate only with close relatives and/or a small number of intimate allies); and in its importance. Contemporary and historically known humans are obligate cooperators: We depend on cooperation for the essential resources of life. This is an aspect of our deep history. Humans have depended on economic, reproductive, and informational cooperation for hundreds of thousands, perhaps millions, of years. There is evidence of hominin large game hunting around 1.8 million years ago (Pickering, 2013), and without projectile weapons, hunting such game with good prospects of success and safety depends on cooperation.

Second, our actions are often governed by norms: implicit and explicit expectations characteristic of our communities about how people like us should act in the circumstances we find ourselves in. These expectations have potential consequences: Violations, if noted, have more or less severe negative effects. The existence of expectations reinforced by formal or informal sanction sets up prudential reasons for agents to notice and conform to those expectations (though not necessarily overriding or decisive prudential reasons). Strikingly, though, many agents in many circumstances are intrinsically motivated to conform to these expectations. Peter Railton takes intrinsic motivation to be central to his account of normatively guided action. As he points out, for many of the norms prevalent in the community, many agents will notice if one of their own acts is inconsistent with that norm; will feel some discomfort at so noticing (even if no one else does); and will feel some inclination to restore conformity with the norm, even if some effort or cost is involved, and even if no one else knows of the violation or is significantly affected by it (Railton, 2006, 2014). Likewise, agents who notice another person violating a norm will have

some inclination to overtly disapprove, even if they themselves are unaffected by the violation. In discussing the evolutionary origins of norms and normative guidance, I will rely on Railton's characterization, because it does not presuppose that being guided by norms depends on cognitive or linguistic sophistication; it leaves these important questions open.

Almost everyone who has written on the evolution of norms and normative guidance has argued for a fundamental connection between human cooperation and norms.¹ Norms – expectations backed by sanctions – and normative guidance evolved as part of the social and cognitive equipment needed to stabilize and expand cooperation. I agree, but with two caveats. First, while the connection between norms and cooperation may provide the selective explanation of norms, those selective facts are not wired into the cognitive psychology of norms. The proximate psychology of normative guidance is not a simple or rigid reflection of the selective factors driving the evolution of norm psychology. Many norms humans internalize and act on have nothing (overtly) to do with cooperation: norms of purity; norms of dress; norms of social distance. Indeed, *prima facie*, many cultures seem to have destructive norms about the relations between sexes, and between adults and children, that are inimical to cooperation (for some extraordinary examples, see Edgerton, 1992). Our account of the evolution of norms should shed some light on their cognitive fluidity. Second, the evolution of hominin cooperation has been a complex and multi-stage trajectory, so even if the evolution of norms and normative guidance has played some crucial, enabling role, we need to identify where, why, and how norms entered the picture. That will be the main focus of this chapter, but I will have something to say about fluidity as well.

I think that *explicit norms* became important relatively late: in approximately the last 100,000 years of human cooperation. Moreover, in my view the establishment of cooperation as a central element of hominin foraging strategies did not require even *implicit norms*. Thus the view defended here contrasts with those recently articulated in the literature on the evolution of human social behavior. Both Michael Tomasello and the researchers within the “Californian” school of cultural evolution – most notably Pete Richerson, Rob Boyd, and Joseph Henrich – take it that norms became important early in the evolution of human cooperation. Despite this disagreement in timing, I take two important insights from Michael Tomasello's work and the Richerson-Boyd-Henrich axis. From Tomasello, I take the idea that human cooperative foraging began with collective action that delivered immediate returns, which were then divided on the spot: Cooperation took the form of immediate return mutualism, rather than direct or indirect reciprocity (Tomasello, 2016; Tomasello, Melis, Tennie, Wyman, & Herrmann, 2012). Tomasello went too far in claiming that immediate return mutualism (of the kind he had in mind) was immune to destabilization by defection. But he is certainly right in arguing that detecting defection is much easier with forms of cooperation that take the form of immediate return mutualism than with any form of reciprocity. Moreover, I shall argue that policing defection in these contexts depends on simple cognitive and motivational mechanisms, mechanisms that were very likely present in the last common ancestor

of humans and chimps. From the Richerson-Boyd-Henrich triumvirate, I take the insight that policing defection must depend on a sanctioning response from all or most of the members of the band or community, not just the individual (or individuals) most directly affected (Boyd, 2016; Boyd & Richerson, 2001). It is the collective response that makes sanctions seriously threatening to the defector, while being relatively low risk to each member of the collective. The Richerson-Boyd-Henrich view is that only the establishment and internalization of norms could both paint the defection as defection and motivate a sanctioning response. That is right once cooperation took a more socially and economically complex form in the Late Pleistocene, but not for its simpler early form. I shall identify a more basic mechanism that would, and in my view did, motivate sanctions against destabilizing defection.

Hominin pathways to cooperation

Many factors affect the scope and power of cooperation. Of these, the literature has focused on demographic scale. That is indeed important. Contingent cooperation – I will cooperate contingent on your cooperation – is stable in very small and only very small groups. Even in groups as small as five or six, freeriding destabilizes contingent cooperation, for withdrawing cooperation in response to freeriding penalizes those who were cooperating as much as it does the freerider. I shall argue that if agents can choose partners for collective action fairly freely, reputation, partner choice, and hot reactive emotions can stabilize cooperation at the meso-level (Baumard, André, & Sperber, 2013). But as these mechanisms depend on intimate and detailed mutual knowledge, on trust and trustworthiness, they do not scale up to larger social worlds. Cooperation then depends on new social tools. For in these larger and more complex environments, agents regulate their interactions and expectations of one another through recognition of social role and function, rather than through specific individual knowledge. Paul Seabright details the many threats to the stability of cooperation in these more anonymous social worlds (see Seabright, 2010). So though scale matters, in this chapter, I focus on two other factors: changes in the techniques and the technologies that made cooperation profitable, and associated changes in its economic basis. In Table 20.1 I present a simple (and doubtless simplified) framework for understanding the transitions in human cooperation. The table synthesizes a series of linked changes in social organization, forms of cooperation, and the social and physical tools that make these forms of cooperation possible. In addition, it suggests approximate and somewhat conjectural dates.

As shown in Table 20.1, the first of these transitions is from the patchy and unstable cooperation characteristic of great ape social worlds to the social worlds of the early Pleistocene, as cooperation became critical to one central element of hominin foraging strategies, and hence to dependence, or near-dependence, on cooperation for vital resources for life. That transition depended on the complete or partial suppression of dominance hierarchies in the life of early Pleistocene hominins. The initial steps in that transition did not depend on implicit or explicit norms. But implicit norms may well have had a role in stabilizing and fine-tuning the Pleistocene social contract.

Table 20.1 Transitions in hominin cooperation

Transition	Key feature of social organization	Cultural innovations that supported the transition	Very approximate dates	Consequences for cooperation
From largely independent foraging to immediate return mutualism	Suppression of male dominance hierarchy	Weapons; perhaps improved communication and coordination	1.8 million years ago to 800,000 years ago (from early <i>erectus</i> to the evolution of <i>heidelbergensis</i>)	Collective scavenging and hunting; home base foraging (hence greater role for female reproductive cooperation); investment in tools becomes rational, with secure possession
Indirect reciprocity becomes important	Good reputation essential to life prospects	Gossip: language advanced enough to make reputation full and reliable Explicit norms; expanded role for ritual in strengthening social bonds/easing social tensions	120,000 years ago to 50,000 years ago	Exploitation of a much broader resource portfolio; more efficient use of territory; risk management through reciprocity; first potentials for specialization
Collective action and cooperation at community level	Segmented society; bands, or sections of bands, nested within larger group	Elaborated kinship systems (often with clan-like organization); ritual life asserts collective identity in response to others; signaling outward, not just to one another	Very Late Pleistocene	Collective action with high costs, perhaps including war
Cooperation in sedentary, complex, and hierarchical societies	Formal and informal leadership positions; significant and enduring differences in material wealth; interactions often mediated by social role rather than direct mutual knowledge	Property rights; quasi-legal institutions, i.e., norms of action linked to norms of enforcement; forager norms of sharing transformed into norms of entitlement and status	Beginning at the very end of the Pleistocene/early Holocene	Great expansion of specialization and exchange; great expansion of the demographic and resource scale of collective action; shift toward the “cooperation with strangers” of mass society

There was no fundamental change in the scale of cooperation by the Late Pleistocene (i.e., about 100,000 years ago). But its economic base changed, more to an economy of reciprocation. It is here, I shall argue, that explicit norms became important. The final two transitions (which are outside the scope of this chapter) were related to changes in social scale and the scale of cooperation. By the Holocene, there are signs of collective action above the scale of individual bands, in discoveries of impressive pieces of environmental engineering. There are Holocene fish traps and drive lines that could not have been built without very significant commitments of time and energy, and with a labor force that no single forager band could field (Frison, 2004; McNiven et al., 2015). There is no evidence of environmental engineering on these scales deep in the Pleistocene. There were, however, significant changes in the technical and economic basis of foraging, and these stressed the Pleistocene social contract. Explicit norms were one of the social tools that managed these stresses, and so their emergence (or their great elaboration) was a phenomenon of the Late Pleistocene (and Holocene), of approximately the last 100,000 years.

Establishing the erectine social contract

I take large and medium game hunting, as first practiced by hominins, to be a form of immediate return mutualism. Identifying specific hominin species in the fossil record is extremely difficult. Especially in the deeper past, we usually have only a few fossils, always incomplete, with very little information about natural variation. *Homo erectus* is generally reckoned to have appeared about 1.8 million years ago, and it seems to have rapidly spread through much of Africa and Eurasia. These hominins were larger and more encephalized than earlier hominins, and I refer to refer to them collectively as erectines, but there is no telling whether they formed a single widely dispersed species or a set of sibling species. The evidence suggests that they were significantly more cooperative than their predecessors. Henry Bunn, Travis Pickering, and their colleagues have built an impressive case for thinking that early erectines were successful large and medium game hunters (Bunn, 2007; Bunn & Gurtov, 2014; Bunn & Pickering, 2010; Domínguez-Rodrigo & Pickering, 2017; Pickering, 2013; Pickering & Bunn, 2012; Pickering & Domínguez-Rodrigo, 2012). That case remains somewhat controversial, with contested claims about the implications of tooth and stone markings on the bones in hominin middens (Pante, Scott, Blumenschine, & Capaldo, 2014). But evidence about the age profile of these bovids, inferred from the bones in these middens, strikes me as convincing. A bias toward prime age adults speaks against the idea that these are scavenged kills. In turn, evidence for large and medium game hunting is evidence for quite high-stakes cooperation, as hunting is intrinsically dangerous and a soak of time and energy. Once high velocity projectile weapons were in use (that is, wommera-launched javelins and bow and arrow technology) an individual could hunt alone or with a companion or two. But when hunting with stabbing spears, or short-range hand-thrown spears, weight of fire must have been important to bring the target down quickly and safely. For this reason, I think Pickering is right to

argue that these early erectines were ambush hunters (which means they could not multi-task, gathering while searching for prey). Hominins were not physiologically adapted for high-speed pursuit hunting,² and when hunting as a pack, it would be very difficult to practice encounter stalking hunting. A pack of spear-armed hominins is just too visible to get close. Animals learn, so while these targets might have initially been naive about the hominin threat, they would soon have learned caution. But while ambush hunting is a form of high-stakes cooperation, for waiting in ambush requires time and patience, and imposes serious opportunity costs (for a vivid ethnographic example, see (Gould, 1969) pp. 10–11), when successful it generates immediate returns for the whole hunting group.

On this analysis, the archaeological record suggests that immediate return mutualism was part of the hominin foraging repertoire by about 1.8 million years ago, perhaps earlier. This form of cooperative foraging is exposed to defection. A member of the ambush party can lurk back when the ambush is sprung, and/or try to wholly or partially monopolize the carcass if it is sprung successfully. But consequential defection – defection that seriously impacted the chances of success, or the value of other portions of the kill for the rest of the party – would be obvious to all present. In some respects, ambush hunting is cognitively, emotionally, and socially demanding. The choice of an ambush site will require a fine knowledge of the natural history of the target; an excellent eye for terrain; great self-discipline in staying quiet and still in concealment, perhaps for hours, in close proximity; and planning and coordination, if the ambush depends on the target animals being driven past the ambush site (Binford, 2007; Pickering, 2013). But in other respects it is robust against noise and minor cheating. As hunting larger game became part of the erectine foraging repertoire, no doubt, at the point of the division, with everyone slashing and tearing away, determined to have at least their share, the spoils were not split with perfect equality. That said, one of the advantages of large and medium game hunting as a foundational form of high-stakes cooperation is that it is tolerant of some noise in sharing the profits. For as size portions go up, the marginal value of further increments goes down. Likewise, once the trap is sprung, it is somewhat robust against friction or a failure to fully commit to the kill: Party size gives some redundancy.

However, it is one thing to detect serious defection, another to police it. Initially, I propose that policing was mediated by hot, spontaneous, reactive, and contagious emotions. A successful ambush will place a band of excited, highly aroused, armed hominins around a carcass being divided, probably at least partly for immediate consumption. The division and consumption of meat is itself highly arousing. A collective chimp kill of a monkey ends up with a mob of excited, noisy, shrieking chimps. In that swarm of slashing, cutting, pulling, and dividing hominins, each with expectations of highly prized food cranked up by success, any attempt to dominate at the kill site would be playing with fire. In Franz de Waal's depiction of the social lives of chimps, he notes a few occasions in which a dominant's bullying went too far (de Waal, 1982, 1989), and the latent resentment of the subordinates flared and spread into a bout of collective aggressive hostility, temporarily suspending the usual

dominance and submission interactions. Risking such an outbreak at a collective kill site by an attempt to dominate distribution would be extraordinarily dangerous. For the existing levels of arousal would make a flare likely, and likely to spread once one individual objects violently. Moreover, in contrast to the chimps, human collective violence would be armed collective violence, with a clear potential to turn lethal. The claim is not entirely theoretical: There is decent evidence of episodic violence in deep history (summarized in Kim & Kissel, 2017, chapter 3). Chimp collective outbreaks are transient and epiphenomenal. In contrast, on this hypothesis the spread, and the threat of the spread, of hot reactive emotions among hunting hominins did have important consequences for early hominin social life. The potentially lethal character of an outbreak of resentment-fuelled anger acted to genuinely deter alpha bullying, though perhaps initially only in the context of this form of collective action. In turn, that meant that this form of immediate return mutualism was evolutionarily stable, as the distribution of cooperation's profits encouraged further cooperation.

It has been suggested to me that implicit norms must already be playing a role in this scenario (in personal communication, by Joeri Witteveen and Rob Wilson, among others). For what would motivate hot-blooded outrage but the thought that an attempt to monopolize the kill (or not do your share of the killing) was unfair? It is possible that implicit norms of fairness were in play in the initial policing of immediate return mutualism, but the model does not presuppose it. Agents can be emotionally partial: deeply resentful of trespasses on their interests, but not at all apt to feel emotional discomfort if they trespass, undetected or unsanctioned, on the interests of others in symmetrical situations. Brosnan and de Waal (2003) report a famous set of experiments on macaque social interaction that have been described as revealing a macaque sense of fairness: The focal macaque deeply resents another macaque being more richly rewarded (with grapes) for passing the same test he does. But to show a sense of fairness, the experiments would need to show that macaques felt some social embarrassment, or some disposition to share, if rewarded by grapes while their social peers only got monkey chow. Nothing like this is shown; the monkey paid with grapes ate them without hesitation. If the emotions that drove the policing of freeriding were self-regarding in this way, policing cheating did not depend on implicit norms. Peter Railton (2006) is right to insist that some degree of impartiality is part of the cognitive psychology of norm-guided behavior. Part of having an intrinsic motivation to conform to a norm is some tendency, however minimal, to feel emotional discomfort at one's own undetected norm violation. So on the view proposed here, the initial mechanism through which cheating is deterred requires only self-interested emotions, like those expressed by macaques' anger at others attempting to get more. That said, it is plausible that the fine-tuning and extension of immediate return mutualism required a more cognitively and emotionally nuanced response.

So, I claim that hot, reactive emotions, emotions that could spread rapidly through an armed and aroused mob,³ would suffice to deter bully expropriation, as the spoils of the hunting were divided. But what of other forms of cooperation that

became characteristic of forager lifeways? If this picture is right, then a salient and foundational form of cooperation, one important enough to change the social and economic environment, could have been established on the basis of hot-blooded suppression of major cheating. But refining an economy of large game hunting – making it reliable enough to be depended upon, for example, in cold temperate climates in which fallback foods in winter would be very scarce – and integrating it with the flow of more reliable though less rich gathered resources needed more. Refinement and integration depend on sustained and reliable control of cheating through the full cycle of hunted, gathered, processed, and shared resources. In somewhat different forms, Kristen Hawkes (and colleagues) and Sarah Hrdy have argued that erectine mothers depended on cooperation in mothering (Coxworth, Kim, McQueen, & Hawkes, 2015; Kristin Hawkes, 2003; K Hawkes, O’Connell, Blurton Jones, Alvarez, & Charnov, 1998; Sarah B Hrdy, 2005; Sarah Baffer Hrdy, 2009; J.F O’Connell, Hawkes, & Blurton Jones, 1999). Hawkes, in particular, has argued that grandmothers help provision their grandchildren, reducing the energetic burden on the infant’s mother, and allowing that mother to wean her children more quickly. Moreover, Robert Wrangham has pointed out that high variance in hunting success suggests that hunting is only a viable form of foraging if paired with foragers targeting more reliable though less valuable resources (Wrangham, 2017). This is part of his more general case that cooking, or at least some form of food preparation that made ingestion and digestion easier, was an early part of our foraging repertoire. These converging lines of argument indicate that erectine foraging included a fission-fusion dynamic with some form of home base foraging. But home base foraging is not stable in a bully dominated social world. A grandmother cannot adaptively collect underground storage organs (tubers, corms, and the like) for her daughter’s toddlers at camp if she is at serious risk of having her take expropriated. Likewise, those who gather plant food and small animals need security of possession if they are to return with their food to a joint campsite. The same is true of other resources. An artisan cannot afford to invest time and energy in making high-quality implements unless he or she can keep them. Bully dominated social worlds select for feed-as-you-go foraging⁴ and reliance on ephemeral tools. Chimps are indeed feed-as-you-go foragers, and they use cheap, throw-away tools. How was minimal respect for possession by the stronger for the weaker established? For in a fission-fusion environment, with different individuals and small parties drifting back to camp, there is no already aroused mob ready to intimidate a potential bully tempted to help himself to granny’s bounty.

Over the one million plus years from the initial evidence of targeted medium game hunting, there is scattered evidence of more regularized and sustained cooperation: the penetration of hominins into less hospitable environments;⁵ evidence of the transport of food back to a home base (including the head of an elephant: Goren-Isbar, Lister, Werker, & Chech, 1994); clear evidence of control of fire just after 800,000 years ago. So we have signs of a slow and uneven move to more reliable, sustained forms of cooperation. As the Acheulean drew to a close (and probably for a half-million years or more earlier) there are archaeological signals of this

refinement and integration. One very striking late Acheulean example is Qesem Cave, a Levantine site (described in Barkai, Rosell, Blasco, & Gopher, 2017; Stiner, Gopher, & Barkai, 2011). At first occupation, at about 400,000 years ago, this is a late Acheulean site (though over the 200,000 years of its (probably seasonal) occupation new forms of lithic technology were introduced). At least at the beginning of the sequence, there is still no evidence of hafted tools or high velocity projectile weapons, so the basic procurement strategy was probably still some form of ambush hunting combined with gathering, and indeed there are signs of the same target selectivity of the much earlier ambush hunting of early erectines – a bias toward prime adults. As such, the basic driver of the meat economy is collective action generating immediate returns. But those immediate returns were not divided and consumed on the spot. Rather (judging from the surviving bones at the site), the kills were disarticulated, and parts not worth the transport costs (hooves) were discarded. Other parts were transported back to home base. The flesh and bones were cooked (the bones for their marrow), probably by roasting, at a very large and hence communal hearth. The meat was then divided and eaten (with gnawed scraps rather oafishly being tossed backward) and the bones broken open. This cave site records not just delayed consumption after a collective kill, but delayed sharing, with the kill being initially divided for transport back to home base rather than for immediate sharing. In addition, consumption is communal, in close proximity to one another and to a hearth that had to be fuelled. Moreover, as Wrangham shows, these game kills were almost certainly supported and supplemented with gathered foods, though these were not preserved at all well at this site. This is an archaeological snapshot of orderly and sustained cooperation. What could select for a more sustained control of cheating and hence of dominance, and what cognitive and emotional mechanisms were needed to enable agents to exert and respond to control?

Refining the erectine social contract: a role for implicit norms?

As the Pleistocene social contract is refined and extended, each individual's decision-making becomes more conditioned on what others will do. As a result, regularities in behavior become normatively loaded, because agents conditionalize their own actions on these regularities. If a pattern is established in which foragers return with their gathered resources to a central place, at which they are shared, or traded, for hunted resources, those returning to the campsite, perhaps after a failed hunt, will resent any breakdown in resource pooling. If a pattern is established in which the young and the old gather fuel and tend the fire, letting the fire die will spark resentment. If interactive regularities in childcare are established, with (for example) mothers taking turns to guard young children at the campsite while others forage, or if a routine develops in which a group of women forage together for mutual aid and protection, deviations from this pattern will cause resentment. In general, as hominin decision-making becomes more linked, so the optimal choice of one depends on the choices of others, and as those choices become guided by regular patterns of

choice, those patterns will tend to become entrenched through informal sanctions by aggrieved agents whose own plans have miscarried because of deviations from the typical. Thus the typical, the normal, the habitual, has a tendency to become a norm in intertwined social worlds. Group hunting, with its implications for coordinated and mutually dependent action over hours and days, its implications for an expanded role for social learning, and its implications for some form of integration and balance between hunted and gathered resources, puts erectines on the pathway to a more and more intertwined social world.

So once patterns in social interaction became established, they triggered expectations of their continuance, and violations of those expectations (sometimes) caused resentment. So what? How do others' resentments effect the fitness of Thag? (After whom the thagomizer is named.) One reason why Thag should care is to minimize the risk of violent confrontations erupting in low-stakes interactions. Weaponizing disputes increases risk, making it easy for a minor squabble to turn dangerous. This selects against aggression for relatively minor gains, even if the aggression would probably go unchallenged, and helps explain the further control of bullying.⁶ For example, if Hawkes is right, erectine grandmothers were armed, and they probably foraged in small groups for protection, as forager women still do (Gould, 1969; Marlowe, 2010). For underground storage organs are extracted with digging sticks, and digging sticks are made from strong and heavy wood (they need some mass), sharpened at each end. A young adult male meeting a party of three or four women returning to camp could probably dominate them and seize what they had. If they were not armed, he could do so essentially free of serious risk. But it would only take one to have a flash of rage for bluff and complaint to turn violent. Loss aversion may not be rational, but it does seem an entrenched feature of human psychology, so those in possession of resources will often be tempted to defend them, even though the potential risks are not worth the gain. If that is right, selection will favor cognitive and emotional variations that improve an agent's control over those behaviors that risk leading to violent confrontations in low-stakes interactions. In higher-stakes encounters over scarce resources, the strategy of playing bourgeois – defend what you have, but do not aggressively attack as a non-owner – is often evolutionarily stable (Grafen, 1987; Maynard Smith & Parker, 1976). Possession is used as a symmetry breaking cue (and is useful even if it is not correlated, as it often is, with a real difference in fighting power). The adult male/female foraging party interaction only roughly fits Maynard Smith and Parker's model of bourgeois as an evolutionarily stable strategy, for the stakes are not of high value, and there are more obvious asymmetries between the agents. But selection may well favor a similar dynamic of avoiding conflict costs, and using the same cue of possession to break symmetry.

Another potentially important factor is reputation. In discussions of wealth, economists distinguish between material wealth, embodied capital (an agent's skills, strength, endurance, health), and social capital. Social capital is the network through which an agent can recruit help when in trouble or need; partners for joint enterprises; allies when facing conflict or challenge; advice and information; and support in collective decision-making. Social capital is central to life success in

ethnographically known forager societies (Smith et al., 2010). Some aspects of ethnographically known forager networks depend on social and cognitive tools unlikely to be available to erectines or *heidelbergians*: Contemporary foragers have elaborated kinship systems and customs of ritual exchange that link agents in different bands. But some factors that make social capital important to contemporary foragers are likely to make it important to ancient foragers as well: support in conflict; support in injury and illness; support in childcare; support in collective action. Social capital is, after all, important in the lives of chimps and bonobos, and so successful Pleistocene hominins were very probably nested in networks of mutual support, with expectations running both ways. As a consequence, our aforementioned imagined grandmothers were probably protected not just by the unlikely but real threat of their collective physical retaliation, but by the social costs of despoiling them. They may not have had a rich enough protolanguage to detail their story. But suppose they returned empty handed, perhaps with minor injuries, and with a new and marked aversion to the bully. To the extent that the bully's life opportunities depends on his having supporters and allies, obvious hostility from a fraction of the band can inflict a telling reputational penalty.

How, though, did those external costs of norm violation come to have an internal echo, so motivation was not merely prudential? Jonathan Birch has an intriguing though speculative suggestion (Birch, in preparation). Normative guidance is a form of skilled action, and he suggests that it evolved first in the context of skilled craftsmanship, and that craftsmanship has deep roots in the Acheulean. For some Acheulean handaxes are beautifully made. The road to norms begins with pride in craftsmanship – caring about one's work, perhaps partly for instrumental reasons, but importantly for intrinsic reasons as well. A skilled craftsman holds himself or herself to a standard of achievement, and is dissatisfied with a product below that standard, whether or not anyone else knows or cares. Likewise, that artisan will find successful, skilled execution intrinsically as well as instrumentally rewarding. Such intrinsic motivations are likely to have material rewards, motivating the practice and care that lead to mastery. As Birch points out, once normative guidance of craft skills is established, we can expect individual standards of appropriate execution to converge (Shipton, forthcoming), for them to become shared through social learning, teaching, and mutual observation. For these forager artisans work communally in a public space (Hiscock, 2014; Stout, 2002).

On this picture, we expect norms of skilled work to gradually become shared and then become explicit in the local community. Skilled artisans became intrinsically motivated to get it right or put it right, and to do so in concert with shared and eventually articulated shared standards. To get to social rather than craft norms, a final, or perhaps parallel, step is to extend the scope of intrinsically motivated, standard-guided actions to social interaction, not just to physical crafts. We saw earlier why selection would favor this expansion: In many contexts, failing to meet others' expectations is penalized. A natural bridge here would be shared foraging activities, like hunting, which have elements of both craft skill and social interaction. There is a way of getting a hunt right, which has both social elements – smooth

coordination, seamless division of the spoils – and precise physical execution. Seeing normative guidance of social action as developed from an initial domain of guiding skilled action makes the cognitive fluidity of norms less puzzling. Those who think normative cognition was the result of direct selection in the Pleistocene for prosocial forager behavior have some difficulty in explaining the openness of our normative psychology.

The demands of reciprocation

In the first half of this chapter, I have sketched a picture of the orderly development of sustained and organized cooperation built around immediate return mutualism. I then suggested that the latter stages of this trajectory probably depended on implicit norms. These are regularities in social behavior that were common knowledge, and because they were common knowledge, they were relied upon in decision-making. As they were relied upon, when expectations were violated, that provoked resentment. As reputation mattered, that resentment mattered, and agents developed intrinsic motivation not to violate others' expectations. However, the cooperative challenges of specialization, trade, and exchange – more generally, of reciprocation – are very different from those of collective action. These new challenges became much more central to cooperative life sometime around 100,000 years ago and increased thereafter. For the economic base of cooperation began to change about 100,000 years ago, with a shift from immediate return mutualism to direct and indirect reciprocation (this is argued in Sterelny, 2014). Reciprocation-based cooperation was still rewarding, but the changes in the foraging economy made monitoring and policing more difficult. Two changes were especially important. One was increased resource breadth. There is reason to think that the *heidelbergensis* and the Neanderthals were large and medium game specialists (thus occupying a top predator niche, with consequences for range size and population density). Over the Late Pleistocene, and especially since the last glacial/interglacial cycle, recent humans were less specialized, exploiting not just large game but seashore⁷ and lacustrine resources, together with a greater emphasis on plants (Shea, 2009; Coolidge, Haidle, Lombard, & Wynn, 2016; Lombard & Haidle, 2012). The other was the projectile revolution: spear-thrower and bow and arrow technology, dating perhaps from 70,000 years ago. The projectile revolution may well have been associated with a much expanded use of snares and traps, as there is a considerable overlap between bow and trap technologies.

These economic changes made monitoring fair cooperation more difficult. As the range of resources exploited by a band expands, resource and role commensurability become an issue. If one agent is providing shellfish, another waterfowl, a third meat, a fourth has collected firewood, and a fifth has returned from a long walk with high-quality stone, it is not obvious what legitimate expectations each has of the others. Even among agents of perfect good will, there would be difficult judgments even if all of these resources came onto the table simultaneously. The less true it is that collective action produces a single divisible resource, the more complex the monitoring problem becomes.⁸ Even when there is a single shared resource, the

monitoring problem can be difficult if different individuals have sharply different roles in the collective action itself. Alvard and Nolin describe one whale-hunting culture's response to this problem: Hunting involved individuals playing very different roles and having rights to quite different shares of the whale (Alvard & Nolin, 2002).

A shift to an economy of reciprocity makes policing more difficult too. If collective action delivers immediate returns to the whole group, defection is against the interests of every other individual in the group. Shirking makes the collective act more likely to misfire; greed reduces the share of everyone else. Interests are aligned. That need not be true in a reciprocity economy. The rock carrier might feel legitimately aggrieved that his efforts at carrying 10 kg of rock over 10 km of rough country are not well recognized, but everyone else might have had a fair deal. There is no default mechanism that will provide him with social support in pursuing his grievance. Interests are less well-aligned. There probably were (or came to be) reputational benefits to third party supporters for someone roughly treated, and his allies might have lost his backing if they did not speak for him at that time (and we see again the importance of reputation and social capital). However, even so this is a more fragile basis for recruitment than a direct attack on one's interest. I doubt that resource commensurability problems originated in the Late Pleistocene. For one thing, as Boyd notes, foragers cooperate in the exchange of services, not just material goods. That is likely to have ancient roots, especially in services to do with childbirth and childcare. However, on this analysis resource commensurability problems were much intensified in the Late Pleistocene.

These stresses were exacerbated by the projectile revolution. The emergence of projectile technology is difficult to date, as it relies on the comparison of ancient stone points to recent ones with known functions. Stabbing spear points tend to be more robust than those of higher speed projectiles. There are plausible arrow heads from about 70,000 years ago, and perhaps projectile points as early as 100,000 years ago (O'Driscoll & Thompson, 2018). Nonetheless, resource expansion probably preceded high velocity projectiles. However, once foragers are equipped with these tools, the size of a hunting party can fall. The extra stealth of a small group more than compensates for its reduced firepower, and thus bow-equipped foragers tend to hunt in very small groups (Layton, O'Hara, & Bilsborough, 2012). This makes search more efficient for the band as a whole, but cooperation becomes a delayed and often indirect form of reciprocity. For these small parties will have their occasional successes at different times. If, as is probable, there is a good deal of natural variation in the size, condition, and species of the animal taken, the meat that one party contributes today will come back in a different version, amount, and condition at some future time. Assessing fair return raises problems of commensurability and time discounting. The expansion of resource breadth has consequences for mobility too, as different resources are exhausted at different rates. Individuals who specialize⁹ in differing resources will have different views as to when the group should shift. One solution to this problem is a shift from residential to logistic mobility; that is, a shift from the band as a whole moving fairly frequently to less frequent shifts of the

home base supplemented by specialist parties leaving base camp, perhaps for weeks, to target specific but distant resources. Logistic mobility imposes its own demands, as prosocial motivation and social integration can no longer be managed by shared daily experience and interaction alone. Group life is more fragmented.

It is at this stage that norms play a central role in stabilizing cooperation. The emergence and elaboration of normatively guided social interaction manage these difficulties in two ways. Most obviously: Norms can *directly specify* what is expected of agents, and what they can expect, in contexts of resource sharing. There are many ethnographic examples of sometimes remarkably elaborate norms of division and sharing (see, for example, Gould, 1969, pp. 16–17; Alvard & Nolin, 2002; Barnard, 2011, p. 77). As Mary Stiner and her colleagues note, in contrasting Qesem Cave with more recent sites:

Among recent humans, the butchering of large animals nearly always involves a chain of focused tasks performed by one or just a few persons, and the butchering process tends to produce well-aligned marks on bone surfaces. These observations have social significance in that butchering procedures guide many of the formalities of food distribution and sharing that follow.

(Stiner et al., 2011, p. 230)

Cooperation as evidenced by the Qesem Cave was orderly, but the cut marks on bones were chaotic. They do not suggest a single agent butchering and distributing the carcass according to understood and explicit rules. Those rules, when they exist, massively reduce transaction costs. Instead of having to negotiate the appropriate levels and targets of generosity when they have been successful, and equally negotiate appropriate levels of social support when they have missed out, agents typically have clear expectations of what they are supposed to give and receive. These expectations are impartial, and known to be impartial, at least in the sense of applying to the community as a whole and being in place prior to any particular division problem. Setting default expectations reduces social friction: Compare markets with monetary exchange at fixed prices with barter markets in which every exchange is an occasion for negotiation. These norms of sharing and division also make social life more transparent, and that makes policing less challenging. For norms reduce the ambiguity of social interactions. As expectations are regularized and are less open to individual negotiation and opinion, failures to reciprocate are less equivocal, and more readily and undeniably identifiable. That does not guarantee third party support to someone badly dealt with, and, of course, there will still be ambiguous and contested cases. But to the extent that agents internalize and commit to norms, those whose expectations have been seriously violated can harness normative outrage to fuel social support. In general, explicit norms are not directly visible in the archaeological record. But ethnography very strongly suggests that in small-scale, pre-literate societies, explicit norms are inculcated through these societies' ritual lives (L. Kelly, 2015), and the increasing footprint of material symbolism in the human

record from about 100,000 years ago (Henshilwood & d'Errico, 2011) strongly suggests that ritual was an increasingly important aspect of human social life from then. I take this to be an archaeological signal of an expanded role for explicit norms.

Moreover, norms can contribute to social peace without being about peace. They can contribute to the stability of cooperation without being about resources, resource division, or conflict resolution. They can do so by helping build social peace and by helping build the community's sense of its own identity and life. For example, Polly Wiessner has recently documented the social consequences of bushmen's customs of social life around communal evening fires (Wiessner, 2014). Bushmen talk in the day is often quite conflicted, with all manner of disputes about resources and much else, and a good deal of tension and even ill-will can build up. Much of this tension seems to be dissipated by the very different register of conversation and social life at the fire, where practical issues are put aside in favor of songs, music, dance, stories, jokes, and the like, exploiting music's ancient effect of building social engagement (Killin, 2017). These norms are not about resources or disputes, but about what to do, and what not to do, in the evening after eating. But, plausibly, they are very important in keeping friction below dangerous thresholds. I suspect many norms of forager life that are not directly about resources and their division, or about conflicts and their resolution, nonetheless contribute positively to the stability of cooperation by their positive effects on community life and social integration within the community.

What about sex?

So far I have written as if the provision and distribution of economic resources were the function of cooperation and the flashpoint of conflict. But sex, sexual exclusion, and sexual jealousy often have been, and still are, conflict flashpoints. Equally obviously, many small world cultures have elaborate norms regulating sexual behavior and constraining sexual choice. So there is an alternative hypothesis about the origin of social norms: They emerged in hominin society to regulate reproductive cooperation (see Boyd, 2018) and to keep sexual conflict at socially tolerable levels by regulating sexual access between men and women. For example, norms of monogamy supposedly function to reduce levels of male violence and to give most adult males a direct fitness stake in their community's success (S. B. Hrdy, 1999). A polygynous environment with highly skewed male fitness leaves groups with a large fraction of males with little to lose and little stake in the future welfare of the group. If reproductive cooperation and sexual access (the thought continues) were normatively regulated, perhaps hominin cultures were structured by norms prior to the Late Pleistocene. For reproductive cooperation may well have been well-established in erectine populations, and, of course, conflict and the threat of conflict over sexual access has very deep roots indeed, though perhaps amplified in hominin evolution by the interaction of paternity uncertainty and male investment in their putative children.¹⁰

While acknowledging the importance of reproductive cooperation and the potentially catastrophic effects of conflicts about sexual access, I am not persuaded

that those challenges to social life resulted in mid-Pleistocene normative regulation of sex and reproductive cooperation. That is especially so given, as I have noted earlier, that there is no evidence of ritual and the use of material symbols by mid-Pleistocene hominins, and ethnography suggests strong links between ritual and normative life.

Let me begin with reproductive cooperation. In my view, that is plausibly explained by some mix of kin selection, direct reciprocity, and byproduct mutualism, the mix depending on the help and helpers. On Hawkes' grandmother hypothesis, grandmothers promote their inclusive fitness by switching from attempts at direct reproduction to aiding their daughter's children, as their own prospects for successful direct reproduction fades. Likewise, if a mother gets inexpensive but important help from her sisters – aid at the birth itself; childcare to allow the mother to forage unencumbered¹¹ – those sisters improve their inclusive fitness. The same is true if somewhat older children (too young to safely forage themselves) keep an eye on their infant siblings. Direct one-to-one reciprocity would be stable too, as this help is cheap to give but valuable to receive. As they are inexpensive, aid at birth and casual childcare (no helicopter parenting expectations here) do not create strong temptations to defect. In some forager cultures, adolescent girls help mothers who are not close relatives, and this is likely to be useful practice for their future experience as mothers. In short: Reproductive cooperation – presumably ultimately the result of the evolution of a longer and very dependent childhood – does not seem especially difficult to explain.

Was the social world of mid-Pleistocene hominins (the erectines and the *heidelbergians*) severely threatened by conflict over sexual access? If so, was this threat managed by norms regulating sexual access? I doubt it, for the following reasons.

Sex, egalitarian environments, and female choice

I have argued earlier that the relatively egalitarian distribution of material resources did not depend on normative regulation. That egalitarian distribution mitigates conflict about sexual access, for it ensures that female choice does not lead to markedly skewed male reproductive success. Polygyny threshold models predict that when male resource distribution is highly skewed, it pays women to choose to become extra wives of resource rich men. The more women make such choices, the larger the group of males with little to lose. Forager societies rarely generate the resource distributions that favor women choosing to be auxiliary wives. There are mobile forager societies in which polygyny is common. Australian Aboriginal societies are notable cases. But in these societies, polygyny is not generated by female choice. Where female choice is effective, and where resource distribution is fairly equal, we do not see polygyny. I have already argued that mid-Pleistocene social worlds were not structured by a strong dominance hierarchy in which one or a few males took what they wanted by violence and intimidation. By the mid-Pleistocene, there were no alpha males in mid-Pleistocene bands to enforce their exclusive claims on the women in the band, suppressing female choice, and excluding less powerful men.

Polygyny by force was not on the table. Mechanisms that equalize males make female choice critical.

Paternity certainty and fidelity

Sexual politics in many *sapiens* social environments is complicated by male investment and paternity uncertainty. To the extent that males support children whom they take to be their own, forgoing mating effort in favor of investing heavily in existing offspring, they have a strong fitness interest in their partners' sexual fidelity. Affairs are a serious threat to fitness, and are potential violence triggers. In the ethnographic present, many cultures have explicit norms about female fidelity, and about male responsibilities to partners and children, and these norms often prescribe extremely serious sanctions for violations, especially of female fidelity norms. However, first, this pattern is not universal in *sapiens* social worlds. Part of the debate about the character of forager hunting turns on whether it is essentially family provisioning plus some investment in social capital for the family through wider sharing, or whether it is investment in reputation for the hunter(s) himself. If the Hawkes-O'Connor social signaling hypothesis is correct, the original *sapiens* family economy did not depend on a normatively enforced sexual contract of fidelity in return for material support. I am skeptical of the generality of their analysis, but their model does fit some cases. Likewise, partible paternity offers another *sapiens* model of male investment in children without an expectation of exclusive sexual access: Each male distributes his support across the women with whom he has had sexual access (Beckerman & Valentine, 2010).

Moreover, even if the support-for-fidelity contract is a strong *sapiens* default, we do not know how deeply this projects into the past. One important unknown in hominin history is when fathers began to regularly and explicitly recognize their children, and when they began to invest substantially in their care. Those two dates need not coincide (Chapais, 2013). More generally, it is very difficult to date the emergence of kinship systems, which in forager societies are often elaborate, and often involve explicit norms of appropriate interaction or avoidance. Kinship terminologies are elaborate and complex, and hence probably depend on the evolution of something close to language in its contemporary form. That is one hint that kinship systems with their norms probably arrived relatively late in the Pleistocene, that is, in roughly the last 200,000 years (Sterelny, 2016). Another is Clive Gamble's idea that the final out of Africa migration is a signal of a stable social identity, one that does not depend on frequent face-to-face interaction (Foley & Gamble, 2009; Gamble, 1998). That too would see kinship, and hence norms about sex and sexual access, as a Late Pleistocene phenomenon.

Dispersed foraging and sexual monitoring

To the extent that Pleistocene families relied on a practice of male support in return for female fidelity, the changes leading to an economy of reciprocity made that practice more fraught. Those changes made it more difficult for males to feel confident of fidelity by tacit monitoring. Once males shift to small group foraging – sometimes

hunting alone – they do not automatically know what others are doing. There are far fewer opportunities for covert dalliance if male foraging groups are large, with males tending to hunt in larger bands. Logistic mobility makes tacit, automatic guarding even more difficult; the men in special purpose teams may be away from base camp for a week or more. This problem is somewhat mitigated by the fact that females tend to forage in larger groups. Perhaps this is for mutual protection, but even so it would make covert sexual activity more difficult. Even so: To the extent that family economies depended on sexual trust, the broad spectrum revolution, and its antecedents; the projectile revolution; and logistic mobility – all made sexual trust more problematic. This may have resulted in cultural selection to make trust less a matter of tacit guarding and emotional affiliation, and more a matter of public, third party policing of explicit norms (especially by the husband's family). This would make explicit norms of fidelity Late Pleistocene, not mid-Pleistocene.

Sex in segmented societies

This view of the later evolution of sex regulated by norms is, in my view, supported by an important ethnographic phenomenon: the third transition in cooperation mentioned in Table 20.1. Ray Kelly has argued that in the relatively recent past, a more vertically complex form of social organization emerged out of forager life, organized in small, mobile bands. In his terminology, there was a critical change from unsegmented to segmented social organization (R. Kelly, 2000). Unsegmented social worlds are those in which the primary form of social organization beyond the band or camp is the specific networks of individuals within the band, with their kin of various kinds, and with their reciprocation partners. These are not usually congruent; different members of a band will have different networks of affiliation. Segmented societies are based on clans, where clan membership is based on common descent from a single ancestor, usually male, sometimes mythical. So socially recognized patterns of descent usually emphasize one sex over the other. In segmented social worlds, individuals are nested in families, lineages, and clans. Each member of a lineage or clan is a member *only* of that lineage or clan. The contrast with simple, unsegmented forager societies is partially one of scale. In unsegmented societies the camp or band is the maximal unit of collective action and sharing, whereas clans typically have members across more than one village or over-night camp, and so segmented societies can organize collective action at multi-village, clan scales. It is partly a matter of social identity: Social identity is much more congruent in segmented societies, and these have a stronger corporate, collective identity, and so there is a much stronger emphasis on initiation and other fusion rituals in unsegmented societies. These are often extraordinarily demanding: As Flannery and Marcus put it, one is born into a family but one has to be initiated into a clan (Flannery & Marcus, 2012). In contrast, in an unsegmented society, as we have noted, the social networks of fellow members of a band are not congruent. Individuals rarely have the same set of kinship relations (especially if there is out-marriage to different bands), and individual reciprocation relations are not congruent either.

Segmented societies are much more heavily normatively regulated than unsegmented societies, with more investment in ritual. One aspect of that is the demanding initiation rituals noted earlier, but more intense normative regulation certainly extends to sex and marriage. Australian Aboriginal cultures are prime examples of segmented societies, and have very extensive and elaborate proscriptions on marriage eligibility, often based on the division of a generation into sections and subsections, with marriage into some subsections, including one's own, prohibited, and others required (see, for example, Meggitt, 1962). There were often fierce penalties for violation. These norms were leveraged by older males, with their control of initiation and secret knowledge, becoming the normative basis for their right to multiple wives (Keen, 2004, 2006). In contrast, simple forager bands have much less heavily normativized marriage practices. In the !Kung, for example, there is some normative regulation: The potential groom is assessed for quality by the bride's parents, and is expected to do bride service. But with the exception of requiring the groom to be a competent hunter (or its economic equivalent) there seem to be few other restrictions (Lee, 1979). Certainly there is nothing remotely like the proscriptions and requirements of Australian Aboriginal marriage demands. Hadza practices seem more informal still: After a moderate degree of sexual experiment, the interested couple just build a hut and move in together. The parents have some informal role of approval or disapproval, but not much more than the right to give advice (Marlowe, 2010, pp. 165–172). Female choice plays a crucial role in partnership formation. If unsegmented forager life is a better model of Pleistocene foragers (even quite Late Pleistocene foragers), normative regulation was not central to family economies, reproduction, and reproductive cooperation.

Conclusion

This paper accepts the common claim that normative regulation is central to human cooperation. Seabright is right in arguing that cooperation among strangers in the Holocene depended on a quite high degree of respect for norms of (relatively) fair dealing. Norms mattered earlier than that: Explicit norms were critical to stabilizing the forager social contract over the last 100,000 or so years, as the economic basis of cooperation came increasingly to depend on forms of reciprocity. But cooperation in the mid-Pleistocene bands of erectines was not initially regulated by norms, even implicit ones. However, once band-level cooperation became a stable and central feature of hominin life, the crank of gene-culture coevolution began to turn, and agents who angrily resented violations by others of their own expectations came to feel, and to anticipate feeling, emotional dissonance at violating the expectations of others, especially those with whom they had an established history of joint action. At this point, accepting the framework of Birch and Railton, normative guidance is beginning to play a role in social decision-making. That said, until the Late Pleistocene, all or most of these norms could be implicit. The more complex economic and social environment of the later Pleistocene selected not just for sensitivity to norms, but for explicit, articulated, and no doubt contested and negotiated norms.

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Notes

- 1 See, for example, Boyd, 2016; Henrich, 2016; Joyce, 2006; Kitcher, 2011; Tomasello, 2016.
- 2 It has been suggested that hominins are adapted for endurance hunting: running prey to exhaustion (Henrich, 2016). But Pickering & Bunn, 2007, argue, to my mind convincingly, that successful endurance hunting depends on very specific ecological conditions.
- 3 That is especially so as these mid-Pleistocene hominins were likely to have impaired impulse control, relative to more recent hominins.
- 4 Frank Marlowe reports that the Hadza do a fair bit of feed-as-you-go foraging, not from fear of bullies but because demand-sharing imposes a tax on the successful, by the less successful (Marlowe, 2010).
- 5 Though still restricted: Clive Gamble estimates that at about 800,000 ybp, humans still lived no further north than 55 degrees Nth and occupied approximately 45% of their final global range (Gamble, 2013, pp. 8, 143).
- 6 Paul Bingham points out this link between weapons and the control of would-be dominants (Bingham, 1999, 2000). His specific picture supposes that the target will be unrealistically passive, and so is unconvincing, but the general point is well-taken.
- 7 To the extent that it has been suggested that there were complex foragers – sedentary foragers with higher population densities and social hierarchy – in South Africa 100,000 ybp (Marean, 2016).
- 8 It is not clear how deep in time the forager sexual division of labor dates to. There is at least some suggestion that it is a *sapiens* innovation, and was not part of the Neanderthal foraging strategy (Jim F O'Connell, 2006). But if Wrangham, 2017, is right, it may well have very deep roots, and so plant exploitation would have been important in the early and mid-Pleistocene. But in any case, it does not generate quite the same cooperation problem, as female gathering returns are often funnelled to the immediate family rather than shared through the band.
- 9 There is certainly gender specialization. In addition, there will be a tendency for specialization to the extent that different targets call for specific techniques that need practice and/or specialized equipment.
- 10 Human sexual dimorphism (often taken to be an index of the intensity of male/male conflict over sexual access) is moderate, and no males in the genus *Homo* have distinctive morphological adaptations for male/male conflict. However, as Ron Planer has pointed out to me in conversation, that might show the effectiveness of the normative regulation of sexual conflict, rather than showing that sexual conflict was not intense.
- 11 Bushman mothers carry very young children on their back when foraging, but once they are 3 or so they are left in camp in loose care (Lee, 1979, pp. 317–320).

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21

POWER, PLAY, AND INTERPLAY

The psychology of prehistoric sexuality

Timothy Taylor

The scope and promise of sexual prehistory

“Venus would unite lovers in the woods,” wrote the Roman philosopher-poet Lucretius in the first century BC, imagining sex during the pre-civilized stage of human existence. He went on to conclude that “each woman was wooed either by mutual passion, or by the man’s fierce force and reckless lust, or by a price, acorns or arbutus-berries or choice pears” (Lucretius, *On the Nature of Things*). Behind the colorful description we can discern a prescient analysis that admitted the potential presence of very different logics, of mutual eroticism, asymmetric physical power, and economic transaction.

All three are clearly observable in the sexual and reproductive behaviors of wild primates studied by modern ethology that might be supposed to provide some starting template for understanding the bio-cultural evolution and diversification of human sex-related behaviors. The question of whether identifying these three factors exhausts what we can safely say, or whether some enlargement and qualification of Lucretius’ brief description is possible, depends on sensitive assessment of a range of data across a number of disciplines, such as evolutionary biology, archaeology, socio-cultural anthropology, psychology, and so on.

This chapter aims to provide at once a critical overview of the complex problems faced by attempts to “reconstruct” dimensions of human sexual experience and perception in the remote past, and some semblance of a “story.” Whether that is a sensible strategy could be debated, but I feel that underlying the varied individual and collective experiences of actors across an immense range of cultural settings, there are some components of a shared narrative that can be discerned.

Possibly nowhere more than in the field of human sexual psychology are matters so culturally context-sensitive while at the same time tethered to basic visceral

emotions. The power of sex, considered as a fundamental drive, continually creates opportunities for essentialist (mainly naturalist) identity claims (concerning what is normal or healthy). Such arguments, while often over-extended, or misconstrued, or factually fallacious, do have their justification insofar as the existence of visceral, species-wide drives and a shared underlying anatomy should make it possible to provide a scientifically underpinned cognitive account that discusses some key aspects of human sexual psychology in the past, even if the contents can never adequately be described from an emic perspective.

If it is possible – indeed desirable – to identify what are increasingly recognized inter-culturally as “harmful cultural practices” in the present (such as female genital mutilation), then there may be a need to discuss the dimensions of psychological harm arising out of asymmetrical power relations in the expression of sexual desires in the past, and perhaps even the distant past. In fact, I would argue that such discussion is obligatory, as a morally neutral description of practice without regard to effects and outcomes, on individuals and groups, would essentially ignore the tensions Lucretius identified, and we would have no rational psychological basis for understanding strategies of engagement, compliance, or resistance, let alone the causes of diachronic change in sexual practice over time.

A caveat that must be made right at the start is that sexuality as a category may possibly be an extremely short-timescale emic phenomenon, borne out of developments contingent upon the philosophical emergence of enlightenment individualism. What I mean here is that the rise of individualism and the emergent sociological paradigm, with its development of a critically self-conscious sexology as a distinct field of research, which inevitably stands in a reflex relationship to its subject(s) and which has led to a modern world with an ever more technologically facilitated and consumer oriented “leisure” sexuality, is a very specific historical phenomenon. But our idea, emerging from this, that there is something to be labeled as sexuality that forms a negotiable and constructible aspect of personhood may not be a particularly relevant consideration for members of premodern and especially prehistoric societies, just as members of pre-consumer societies had a very different conception of the idea of individualized dietary choice. One overall expectation in attempting to reconstruct the psychology of what we term sexuality in past societies is that behaviors were probably far more normative and far less open to any self-conscious scrutiny; even the basic idea of “sex” forming a separable behavioral realm (clear, certainly by the time of classical Greece, notably in Plato’s *Phaedrus*) is unlikely to predate the broader scale occupational specialization of the early urban societies and empires.

If human sexuality as a general concept is complex, and signals all sorts of areas and levels of disagreement, controversy, and prejudice from the outset, then attempting some discovery and description of human sexuality in the remote, typically prehistoric past might seem hopeless. But the attempt should at least be made, even if the results, such as they are, may be flawed – “Truth,” as the philosopher Francis Bacon famously observed (*Novum Organum*, Book II, Aphorism 20), “will sooner come out from error than from confusion.” There are two, not easily separated,

reasons for making the attempt: the first being to gain further knowledge of the past for its own sake; the second to throw light on the prior conditions of human experience so as to deepen understanding of the various relevant phenomena in the present and future. The latter involves, in particular, a duty to counter particular classes of contemporary normative assertions that make appeals to unsupported or dubious claims concerning “how it was in the past,” claims that are often based on what can be understood as naturalist assumptions but which on closer examination often depend on cultural expectations.

As with other prehistory thematics, reconstructing aspects of human sexual psychology, along with both actual behaviors and cultural norms, expectations, and interdictions, involves paradigmatic sensitivity at the three levels identified by Masterman in her classic 1970 discussion of forms of, and constraints on, framework assumptions, viz (1) metaphysical, (2) artifact/construct, and (3) sociological (Masterman, 1970). At the metaphysical level we need to understand that the definition of sexuality itself is emergent, evolutionarily and historically speaking, and auditing it at the time of writing does not necessarily mean its contents should be seen as relevant for all places and times. In terms of the so-called artifact or construct paradigm, it is clear that interdisciplinary research is providing the means, especially through aDNA and isotopic analysis, to say much more than was previously possible about sex and status differences in past populations, and thus shine independent light on issues that had been viewable through the lens of archaeology alone. Lastly, in terms of the sociological paradigm, we must note that the subject of human sexual behavior and ideas about sex and gender are liable to be remarkably strongly colored by fashionable assumptions and (worse) tacit or implicit prejudices that influence our idea of what it is plausible to expect of humans in behavioral terms.

Probably the hardest dimension in judging this is to gauge the extent to which *what is not currently fashionable* is potentially relevant, even crucial, to building an adequate account of phenomena. While we cannot rule out the issue of unknown unknowns, there are some clear areas where themes, concepts, and categories once thought central to understanding human sex have been progressively written out of accounts. Two, in particular, seem worthy of special mention: motherhood and the capacity for love. These may be thought to exist as different kinds of thing, the former being a social recognition of a concrete functional reality (conceiving, bearing, and nursing offspring), the latter a category of emotion that, while always having rather specific historical contents and many forms, of which perhaps only one is erotic, nevertheless ultimately depends on neurologically underpinned bonds of affection and dependence that appear to be observable beyond our own species (in pair-bonding water birds, to give one example); it can also be argued that motherhood is not easily separable from a capacity for love (see further Rebay-Salisbury, 2017).

The theme of motherhood in particular turns out to be central in grasping the history of our understanding of sex in nature, and the nature of sex, as well, it turns out, as in grounding systems of gender in something more concrete than the internal psychology of identity claims. Put another way, the functional and typological categories involved are to some extent a reflex of presupposed categories in

the minds of human observers of nature and the natural urges of humans, not just those belonging to the emergent class of philosopher or scholar over the past two millennia, but practical observers, such as (for example) domestic livestock breeders, marriage-arrangers, and midwives.

This short overview of sexuality in prehistory can do no more than indicate the dimensions of the problematics involved. Relevant are: (1) a discussion of epistemological issues; (2) an analytical survey of sexual and reproductive behavior in nature, especially in primates, who provide some kind of proxy data for behavioral possibilities and valencies present in the period of early human evolutionary development; (3) observations on contemporary human sexual and reproductive practice, much of it clearly emergent, insofar as it is enabled by many recent advances in technology that were unavailable in either historical or prehistoric periods, but which nevertheless can be seen as connected to the behavioral flexibility or lability observed in our natural background. Important too are (4) anthropologically and historically documented case studies that indicate how the range of actual human sexual and reproductive behavior can be constrained through the operation of cultural norms (this includes discussion of mismatches between culturally approved routines and actual practice); these help us to identify and assess (5) the kinds of sources available for understanding human sexual and reproductive behavior within a prehistoric context, in general on the basis of archaeological and biological data.

I will end this chapter with synthetic and diachronic reconstructions or characterizations of sexual and reproductive behavior for particular area-periods and/or broadly defined cultural evolutionary "stages," coupled with a meta-commentary that returns to some of the underlying problems of analytical versus interpretive language, and the yet more fundamental issues of historicism versus praxeology (basically, whether our attempt at analysis and interpretation is more a mirror of contemporary concerns than a bodying forth in some translational form of genuinely preexistent past realities). Additionally, it should already be clear that there are significant complexities in importing terminologies from modern psychology and sexology to past cultural contexts, and the reader needs to extend a certain indulgence to the writer here for the unavoidably *etic* (and thus to a degree anachronistic and ethnocentric) use of terms.

Granting that the category terms one might use need to have (and are meant to have) a comparative function, I propose that an analysis of human sexual behavior should best fall under the four key headings of biological reproduction, power, pleasure, and social control (or social benefit). These labels are not implied as mutually exclusive strands relating to motivation and actual behavior; rather they are a heuristic device by which I hope it will be possible to identify particular emphases in particular trajectories of cultural development.

I would also submit that the approach overall needs to be an interdisciplinary one, as without mutually independent lines of reasoning, interpretations of (to take one example) prehistoric imagery may represent little more than a Rorschach test; that is, the interpretation will primarily depend on the prejudices, overt and tacit, of the analyst. Indeed, I was accused of precisely this in one review of my book *The*

Prehistory of Sex: Four Million Years of Human Sexual Culture (Taylor, 1996), despite individual interpretations being constrained (as I thought) by broader diachronic and interdisciplinary contextualization. I now see that I did not make my epistemological system (such as it was at that stage) particularly clear, probably in an attempt to avoid involving the reader in a technical discussion whose purposes might have seemed esoteric. I sketched the background in a more technical way in the follow up paper a decade later in the *Journal of Psychology and Human Sexuality* (Taylor, 2006). That it is possible to add significantly to that picture now is down to two factors, neither completely internal to archaeology as a discipline in itself.

The kinds of archaeological data on sexual behavior have remained the same, being fragmentary, tantalizing, and patchy; but in the intervening period, far more work has been done on the range of and constraints on both primate and human sexuality, and on sequencing ancient and modern DNA. This last may not look directly relevant to sexual psychology, but it clearly now occupies an important place as it provides both proxy and direct evidence for the kinds of reproductive choices our ancestors actually made, and therefore throws light on one important dimension of sexual behavior.

Evolutionary perspectives

Perhaps the only real certainty in terms of characterizing sexual behavior in human prehistory is that there was enough reproductive activity to perpetuate our lineages, and enough selection pressure on inherited characteristics to drive evolution, notably encephalization but also an overall decrease in sexual stature dimorphism (the average body mass difference between males and females) through time, accompanied by progressive gracilization – the loss of skeletal robusticity and sharp reduction in canine size in particular. Sexual dimorphism, where adult males are larger and stronger than females – not just on some statistical average, but standardly and significantly – is the observed pattern in chimpanzee and gorilla populations, and is considered a correlate of communities characterized by a polygamous alpha male with long sharp canines who keeps weaker males outside the breeding pool for as long as possible, while females occupy a generally subordinate position. The progressive and generalized overall reduction in sexual dimorphism, which starts in the deep evolutionary epoch and continues into the Holocene present, albeit punctuated by retrograde episodes, is thus a litmus test of changes in certain kinds of social and sexual relations.

The mate selection choices our ancestors made are the primary basis for the evolutionary distance between then and now. This was recognized by Charles Darwin in his pioneering formulation of human evolution, in which he argued that a female preference for more intelligent male partners, whose enhanced cognitive capacities would confer survival advantages on offspring, was the reason for the dramatic threefold increase in cranial capacity between humans and our nearest living relatives among the great apes (Darwin, 1874).

The problem, perhaps, with the sex part of any prehistory of sex is that sex as we know it does not have much of a prehistory before hominins. Primates, essentially,

have reproduction-initiating acts of penetration, but not sex as a developed activity. With the “act” lasting just ten seconds in chimps, to what extent can we equate the pleasure we as a species can derive from sex with a rapid sperm-pumping action in chimpanzees? That a pre-set for sexual enjoyment exists in primates is clear – *vide* the well-documented instances of same-sex sex among female Japanese macaques. So, I am not saying that sex as an extended, shared (and thus socially structuring) pleasure was not a *potential* in other nonhuman primates, and perhaps in other vertebrates, but that it likely emerged only rarely in this guise.

Evolutionary speaking, everything starts with a knuckle-walking ape ancestor, the common ancestor of modern humans and modern chimps, now datable within the broad period of 13–7 million years ago, according to how the genetic clock is interpreted. Bipedalism began in the period between 6 and 4.2 million years ago, with the principal emergent genus of upright-walking hominin, the Australopithecines. These savannah apes were increasingly developing a bipedal gait, which eventually became habitual, and with it a hands-free capacity that encouraged advanced manipulation of objects (tool use) and the development of face-to-face, increasingly vocally and visually signaled and mediated social contact.

Australopithecines were characterized by males who were still significantly larger than females, indicative of frequent and intense intersexual competition (Kimbel & Deleuzene, 2009). In behavioral terms we must envisage brief, aggressive mating, no male care of infants, and sperm competition – females would have been subjected to multiple competitive matings in which the removal and/or flooding out of the sperm of male rivals was key, with irritation of the vagina by penile spines to discourage further activity (if we can extrapolate from living primates; we should note that primate females are also known to pursue active strategies of resistance, e.g., Morrell, 1993).

Nevertheless, although Australopithecines display stature dimorphism on a similar scale to earlier forms, and to living great apes, they also show marked canine reduction, suggesting that at least some of the “I can bite you” threat was, if not exactly evaporating, at least transferring itself over to extrasomatic items, such as choppers and handaxes. The earliest deliberately modified chipped stone tools are now securely dated to 3.3 million years ago (Harmand, 2015). The significance of the replacement of innate biological capacity with extrasomatic capacity should not be underestimated: Once tools and weapons were produced to do the job of teeth and muscles, then a potentially sex-blind artifact-world came into being, in which females as well as males could access the benefits.

Reduction in dimorphism is thus usually taken as an indicator of a systematic shift away from such a polygamous alpha male pattern. Writing *The Prehistory of Sex* back in 1996, I was not fully aware of the potential complexities in this (Taylor, 1996). In 1981 Owen Lovejoy had argued for the early emergence of pair-bonding in human ancestors: females at base camp, tending to children, being protected by their own chosen male mate, who hunted and used tools to bring home the bacon (or antelope) (Lovejoy, 1981). I was critical of Lovejoy’s provisioning hypothesis as it assumed the emergence of monogamy in hominins, whereas the historic ethnographic record

did not show that behavior. Viewed in that way, the Lovejoy provisioning and pair-bonding hypothesis could be seen as an exercise in ethnocentric anachronism, back-projecting a modern North American, romantic, pair-bonding ideal into prehistory, where, it might well be argued, polygamy must have been the rule. Male humans in the past, like male gorillas, had harems, and cut younger males out of the breeding pool while subordinating females.

I was not alone in finding the hypothesis uncomfortable as an evolutionary explanation (cf. Falk, 1997), but it did not seem to make much cultural sense either (I had argued that the Mesolithic period may have seen a more *laissez faire* attitude toward property, including property in people, and that only with farming did we see the real rise of engrained sexual inequality). Lovejoy's hypothesis did, however, provide a way to understand gracilization and the reduction in sexual dimorphism. A male gorilla weighs three times as much as a female gorilla, but this is not true of humans, where weight, stature, and strength have increasingly converged (though with local exceptions). How, also, could one explain how developmental slowing – neoteny – was supported in hominins on their way to being “us,” if not with something like the partnership in childcare implied by the provisioning model?

Perhaps, really, the problem here was completely hidden from me when I was constructing my argument, for what turns out to be quite an interesting reason – viz the idea of a static Gestalt of the “primitive” past. I had in fact fallen into the same trap as Lovejoy – or, perhaps, better put, he had been unaware of the trap and had therefore developed a hypothesis that might well be right for the evolutionary timeslot in question even if it was historically false at a later point. What I had not considered was that harem and polygamy societies in humans might represent a culturally supported *reversion* to a primate-power mode that had in the intervening periods of evolution and early prehistory been effectively suppressed.

The work of Lovejoy's student Philip Reno on gene deletion (Reno, 2017) shows clearly that the loss of penile spines in male humans, alongside the loss of biting canine teeth and a threefold reduction in testicular volume (meaning that sperm competition was fading fast as a reproductive strategy), signals a move toward a more pleasurable, shared form of sex and therefore enhanced possibilities of sexual love and long-term pair-bonding that would have been a *sine qua non* for building larger brains.

Darwin's sexual selection explanation for the appearance of large brains has remained important in evolutionary biology, despite unease over the logic of female hominins choosing larger-headed mates during a period when the biomechanics of bipedalism were placing ever greater selection pressure on a narrow pelvis. That pelvic-cranial mismatches can be lethal to mother and child is not only a contemporary observable, but is archaeologically attested in the phenomenon of so-called “coffin birth,” where the full term fetal skeleton is found to be lodged within the pelvic canal (Taylor, 1996). It is thus plausible to imagine that female mate choice was influenced by other significant factors, such as a preference for neotenic (or child-like) features. This is because these would broadly correlate with full term delivery at a less developed (and thus less cranially enlarged) fetal stage, with rapid

cranial enlargement continuing in the extra-uterine environment in the first year or two after birth.

It is indeed ontogenic retardation, with significantly enhanced infant brain growth, that forms a major distinction between us and the great apes, meaning that our children are born in a far more helpless state, and complete significant amounts of their neuronal expansion in an extra-uterine cultural environment (Taylor, 2010); in short, female hominins may have rather searched out mates who were primarily playful rather than distinctively large-headed. The idea of ontogenic retardation, the birth of ever more helpless babies, would have necessarily required the elaboration of soft material technologies such as carrying slings (effectively an external uterus: Taylor, 2010) to facilitate the care and transportation of infants who were born progressively more underdeveloped. This conclusion is consistent with Reno's gene-deletion conclusions: In "marsupial hominins," a life-long pair-bonding commitment could well have been a critical enabling factor.

Genus *Homo*, emerging from around 2.5 million years ago, sees significant encephalization, which will eventually lead to ritualization and institutions (such as marriage) that formalize behaviors into enforced/enforceable norms that enshrine monogamy and extend the altruistic aspects of love more broadly between individuals and generations. But what has become increasingly obvious through the ever wider and more detailed application of aDNA analyses is that the (pre)history of interbreeding between different hominin populations is complex and highly dynamic. Putative evidence for this, such as the 28,000-year-old skeleton of the Lagar Velho I boy from Portugal, who appeared in formal aspects to have been a mixture of Neanderthal and anatomically modern human, remained in dispute throughout the 1990s, as the idea of hybridization seemed problematic, even though it seemed logical to believe that populations of highly encephalized, upright-walking, tool-using, and verbal hominins were unlikely not to have found each other attractive enough to overcome differences and participate in sexual activity, whether or not that produced viable young (Taylor, 1996); new genetic data now make it far easier to talk more securely about "Homo promiscuous" (Barras, 2018).

However, it has to be said that in the 1980s and 1990s there was also considerable debate about whether Neanderthals had any capacity for symbolic culture. At that time, the idea of a sharp species divide between *Homo neanderthalensis* and *Homo sapiens* was a prevailing orthodoxy, as reflected in nomenclature that replaced the three-part terms *Homo sapiens sapiens* and *Homo sapiens neanderthalensis*, where the final term indicates sub-species variance, with the emphatic two part terms *Homo sapiens* and *Homo neanderthalensis*. It was even doubted that Neanderthals had the same gestation period as *sapiens*, with some arguing that a longer gestation was not impossible. Under such conditions the idea of interspecies sex, while remaining hypothetical, was not expected to leave any physical trace in the form of hybrid or mixed offspring. Since that point, however, sequencing of both Neanderthal and human DNA has proven successful, and we have also witnessed the discovery of at least two new populations of *Homo* – so-called Denisovans (a Southeast Asian *Homo* population variant, first discovered at what may be the extreme northwestern edge

of their range, in the Altai region of southern Siberia) and *Homo floresiensis*, an isolated island population of dwarf humans whose origins are highly contentious (but who could just possibly be the descendants of a very early wave of “out of Africa” *Homo habilis*).

Although the research picture is changing rapidly, as novel data undermine once widely held assumptions, a firm picture of interbreeding between relatively distinct populations has emerged. Highlights of this include the revelation that modern human populations outside sub-Saharan Africa carry a significant (2 to 4% on average: Barras, 2018) residual Neanderthal DNA component; a similar result appears in the case of “Denny,” a mixed Neanderthal/Denisovan juvenile female skeleton, who appears to represent a second or third generation offspring following a mixing event (the term “mixing” is used here in preference to “hybridization,” as it is not clear to what extent isolated species concepts should now be applied in the case of sexual and reproductive iterations among a much more loosely defined *Homo sapiens* species).

What is perhaps most interesting in these new results is that in the “Denny” case, we see the result of a male Denisovan reproducing with a female Neanderthal (Warren, 2018), yet the generalized genetic legacy of Neanderthals among modern non-African humans appears to be Y-linked and does not reveal itself on the female X chromosome. In this case, then, we have an indication that it was male Neanderthals who had access to incoming “out of Africa” *Homo sapiens sapiens* females. These data are complex and emergent and consistent with at least two scenarios, themselves not mutually exclusive. The first is that sapiens females were traded into Neanderthal populations as goods, or were systematically taken captive by them. The second, which is perhaps more strongly supportable as a hypothesis, is that there were sexually asymmetric reproductive issues at the level of viable pregnancy that meant that even if sexual relations between the contact populations were equal and equitable, female Neanderthals were for some reason unable to sustain mixed (or in this case perhaps the term “hybrid” would be correct) fertilization, implantation, and gestation after sex with male sapiens, though not vice versa (yet they could do so with male Denisovans) (Mason & Short, 2011).

The symbolic revolution

There are few direct (sexual) behavioral traces surviving from the period of the most dramatic encephalization, so allow me to skate swiftly over important issues such as the origin of language, the beginnings of ritual and death-related behaviors, and the earliest recognizable art, and whether these things were gradual and emergent or, by contrast, were bio-genetic or bio-cultural event-based phenomena (that said, such issues are considered by others in this volume; Donald, Burghardt, Pettitt, etc.). What is clear is that, after a particular archaeologically trackable point in cultural development, we can begin to speak of human sexual culture or cultures, and the presence of category ideas concerning sex and gender.

The new, more complex situation starts to come into focus in Eurasia during the Upper Palaeolithic period, after around 40,000 years ago, when a suite of material artifacts and interventions, including cave painting and figurine production, in which phallic depictions, actual mammoth ivory and limestone imitation phalluses, and gynecologically explicit female statuettes are frequent, display a clear interest in sex and reproduction (see the following text on the interpretation of Venus figurines). In certain contexts where the data are sufficient, it is plausible to infer the existence of enforced norms within a broader range of possible human sexual and reproductive behaviors. In later prehistory and in the more immediate nonliterate past, among societies about which archaeology remains a major source of information, sexual cultures can at times be traced in some detail, and sometimes become connectable to data from outside observers (as in classical, historical, and ethnographical accounts of the exotic behaviors of “other” peoples).

Within this most recent timeframe (roughly the last two to three thousand years) it is clear that global cultural diversity includes a wide variety of approved and non-approved sexual behaviors, constrained always by underlying possibilities (or potentialities) of the human mind and body, and available technologies that have played an increasing role over time in the evolution and diversification of both desire and practice, as well as shaping or modifying (not always intentionally from either an individual or group point of view) the kinds of opportunities available.

Current population-level data on sexual behavior in North America, for example, discern a “sex recession,” with a generation delaying the start of adult sexual activity and having sex less frequently than their predecessors (Julian, 2018); while the reasons for this are disputed (the availability of technological and on-line “substitutes” for intimacy and new etiquette-based and work-pattern dependent barriers to direct interpersonal engagement are widely considered as part of the picture), what this does tell us definitively is that sexual behaviors are remarkably sensitive to cultural environment, and do not always assert themselves merely as instinctual imperatives.

One way of getting a handle on this archaeologically is to consider both Bourdieu’s use of the *habitus* concept (Bourdieu, 1977) and J. J. Gibson’s terminology of “affordances” (Gibson, 1979), and their further development in materiality theory. So, for example, we can observe that in the winter months in northern latitudes family groups might be constrained to spend considerable time within small shelters such as igloos, or, to give a Neolithic example, live together within the iconic single-room houses of the kind discovered at Skara Brae on the Island of Orkney. Such physical material settings would have constrained people who wished to have sex to only a very few practical locations where the possibilities of privacy were sharply limited compared to the opportunities that would typically present themselves to communities living in a warmer and more climatically forgiving Mediterranean or Mesoamerican environment. Such difference in material conditions presumably acted reflexively on the very essence of concepts such as privacy or intimacy (or, in fact, the cultural-specific or emic concepts that we might more or less roughly translate using those terms). Not only must such different settings have created different valencies for understanding (actually, inferring the concepts akin to) exhibitionism,

disinhibition, voyeurism, etc., but they created different gradients of social control, perhaps crucially in the field of reproductive choice and the hierarchical enforcement of rules over the bodies of others.

Perhaps the most striking items that might be referred to as objects of human sexual culture are the so-called Venus figurines of the Eurasian Upper Palaeolithic, the most famous of all being the figurine from Willendorf II in the Austrian Wachau. I have reviewed elsewhere the wide range of interpretations made of this and similar figurines, with their gynecological explicitness, sketchy or absent facial features, and occasional indications of binding (Taylor, 1996, 2008). Ideas about them have ranged from a form of prehistoric pornography – glacial hunters' idea of the perfect female form – through claims they represent a Great Mother Goddess, central symbolic personage in an ancient and peaceful matriarchal society, to the idea that they represent women's self-images, made by and for women, and even that they may be advertisements for facility in textile production. However, despite discovery in 1908, and a wealth of description and speculation, it was not until 2008 that formal documentation was made of the fact that the anatomical detail of the Willendorf II limestone figurine includes a clitoris (Taylor, 2008).

Discussion of this feature, along with a close analysis of the attributes of several other related figurines, allows the argument to be constructed that in some ways short-circuits the controversy over whether the images are designed for a male or female gaze, or made by men or by women. In terms of materiality theory, and affordances, what is certain is that these objects are exchangeable, as well as being permanent and unchanging. They seem to represent the female form at a particular life moment – full term pregnancy (the navel is often prominent, and in the case of the partial figurine from Kostienki, who has her hands bound together, the navel is actually everted). Coupled with the lack of male representations of a similar kind, we can with some safety say that not only do the Venuses form part of an elaborate sexual culture of some kind (in which life-size carved phalluses and cave paintings of ithyphallic zoomorphs also figure), but they are part of the instantiation of gender categories. The very depersonalized facelessness of the forms, coupled with their gynecological explicitness, tell us that these are *types*, not individuals. As if to underline this, the recent discovery of the earliest of all examples currently known, at Hohle Fels in Germany, dating to between 35,000 and 40,000 years ago, has genitalia that dwarf the stick-like legs and huge, upward-pointing breasts; by contrast, the place of the head is merely a small knobble or bump, carved so as to form a handy attachment point were the figurine to be worn like an amulet (Conard, 2009).

Although the Venus figurines are naked, this probably contrasted with the everyday appearance of humans in these latitudes by this period, where sophisticated clothing had become the norm, along with cosmetics and jewelry. From burials at this time and later, we see the emergence of the idea of a gender expression in terms of the clothing of males and females becoming differentiated and increasingly used as the primary identifier of sex. This metastasizing of sex from the biological body outward onto material things obviously creates a new level of complexity as, coupled

with the trend of decreasing dimorphism, it means that it became possible for males to dress as females and vice versa.

So far in this essay I have treated sex as a source of power and pleasure and a means to reproduce within a tacitly heterosexual framework, as much of my focus has been on the evolutionary changes brought about by particular mate choice decisions. But, as the reference to the naturalist fallacy at the beginning should make clear, the argument that “normal” sex must be heterosexual is not being advanced. Male and female same-sex sexual behaviors are well documented in many vertebrates, and are common among higher mammals and apes: The drives here are certainly to do with pleasure and dominance hierarchies, and clearly do not relate to reproduction (at least directly: Allegiances cemented through mutually pleasurable same-sex activities may help build and support networks that can benefit the care and protection of infants).

Past a certain point, however, it may be expected that same-sex liaisons became more problematic for participants, insofar as symbolic culture and the emerging concept of gender roles increasingly brought “ought” ideas to the fore; that is, as sexual culture became elaborated, so did normative rules about the kinds of sex that were approved and disapproved. Thus, as Walter Williams pointed out in his ground-breaking study of non-binary sexual relations within Native American communities, “two-spirited” people – males and females primarily attracted to their own sex – typically legitimized their biologically homosexual relationships by making them culturally heterogender (Williams, 1986). The mechanism was occupational and sartorial: The woman dressing as the man and hunting became, socially speaking, a husband who could take a female wife to whose offspring (conceived with biological males to whom the wife was not married) she became father; *mutatis mutandis*, males cross-dressing as women could be taken as wives by men (and even given to other men as wives, as described in some detail in John Tanner’s early nineteenth-century eyewitness account of the Ojibwa: Tanner, 1994; Taylor, 2006).

Archaeology increasingly recognizes the frequency of such cultural play, swapping sex-conventional gender markers in relation to bodies; and from classical sources we know that what we would now consider hormonal interventions were becoming understood as potential aids for transitioning: Ovid, for example, in the context of describing the transvestite priests of the nomadic Scythians, issued a health warning against drinking the urine of pregnant mares, a fluid now medically proven to have a powerful physical feminizing effect on the male body (it contains a high level of conjugated estriol compounds: Taylor, 2006).

Summary and conclusion

Having stopped on the threshold of written history, and the massively diverse story of sex and sexuality within historical cultures and civilizations, it is perhaps worth trying to provide a diachronic overview. This is necessarily very broad-brush, but a rough evolutionary and culture-evolutionary trajectory over the last several million years might be as follows.

From 14 million to 4 million years ago: Heterosexual sex was fairly perfunctory in terms of duration, and females were fought over by males; by analogy with other primates, the possibility that females in particular cultivated same-sex practices as a kind of extension of grooming practices, and as an aspect of mutual support, should not be ruled out.

From four million to 100,000 years ago: The beginning of the transfer of power from the somatic body to the external artifact was complemented by the beginning of a reduction in dimorphism, paving the way for encephalization, which itself might in part have been supported by a move toward pair-bonded relationships.

From 100,000 to 10,000 years ago: A continuing decrease in body size dimorphism means that male and female adults became increasingly equal, with overlapping strength ranges and the possibility of effectively switching gender roles. This becomes elaborated as the emergence of symbolic culture facilitates the partial transfer of sex and sexual ideas over to material things: sexual representations and objects, and sex-specific clothing. In this period we see the emergence of the idea of gender as a complicating factor that can begin to trump biological sex in certain contexts.

From around 10,000 years ago: As we move from the final Upper Palaeolithic cultural period into the post-glacial Holocene, we see the increased possibility of accumulated wealth, including wealth in terms of holding property in people and in forms of inheritance. Lineage becomes marked (as we see in the systematic emergence of cemeteries and the multigenerational development of communal ritual centers). Increasingly this can allow women and children to be treated as property, with their possession and control a marker of political power and status. Culture now underscored sex differences, whose appearance was weakened by reduced dimorphism, through an emphasis on strict dress codes that distinguish males from females as two firmly separated classes (a separation that in elaborately ritual societies can actually be conceptually *sharpened* through cross-dressing shamanism).

From around 5,000 years ago: We see the emergence of civilization, that is, of complex societies with cities, numeracy, writing, and specialization. These societies, arising independently in several separated parts of the world as an ultimate outcome of the intensification processes of what is broadly termed Neolithization, cultivated sets of ideas about the body, health, and illness, including ideas about good and bad sexual practice. As with all other aspects of life, sex also became atomized or specialized, starting to become what we recognize it as today: a sphere of distinct interests and a set of behaviors (sexual behaviors) that are bounded and distinct from non-sexual behaviors. This distinction did not always follow the same distinction of public vs. private, and early states varied considerably in the forms of public depiction of sexual activity, as in its actual “performance.” The transactive potential of sex, a subtext in consent or acquiescence since early evolutionary times, became formalized in institutions such as temple prostitution and army brothels. Typically, these elaborations were to the disadvantage of women viewed as a class, but (especially) young people of both sexes from the lower and poorer echelons were exploited.

Within the ethnographically and historically “modern” period (coming up into the twentieth century), it appears that polygamy was the most prevalent recorded

marriage pattern, at least in terms of an absolute count of different cultural communities, if not in terms of total global population numbers. This is or was true for most tribal and chiefdom societies, and characterized many early states, particularly at the upper social levels (and polygamy remains a pattern within some modern theocracies). Whether the different forms of polygamy (in tribal and in some state societies) are structurally linked is hard to say, and it is hard to gauge the origin or antiquity of the pattern, whether it has been an underlying continuum or just a valency that is favored in particular socio-economic and cultural situations, while monogamy as an ideal and actual practice was the more significant long-term evolutionary driver (as was already discussed earlier in connection with the Lovejoy hypothesis).

Certainly, the typical patterns in post-enlightenment liberal democracies have become complex, with the Judaeo-Christian model providing an ultimate moral basis and template for developments such as same-sex marriage (which, as we have already seen, have been recognized as legitimate in other premodern societies when clothed, literally, in a heterogender manner: See William, 1986, as noted earlier). Nevertheless, permanent monogamous pair-bonded families have increasingly given way to sequential arrangements and non-formalized structures, and there has been a fringe but significant emergence of (or perhaps simply a more open acceptance of) other patterns of association (such as polyamory), possibly connected to the individualization and commodification of sex as leisure and play; alternative forms of sexual expression are also increasingly accepted, at least by some legislatures and communities.

How these various phenomena will evolve and develop is not known, but I hope it is by now clear that the biological and cultural factors at play, along with the symbolic and technological interfaces, are by no means recent. The prehistory of sex, if it can tell us anything, shows that many of the problems and issues we face and debate in terms of approved and non-approved behaviors, the desirability and efficacy (or, by contrast, danger and degeneracy) of particular kinds of images and representations, and so on have a deep past. Advancing our understanding of that may help us to more clearly see the benefits and hazards of particular options for future forms of society.

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PART IV

Prehistory from the
perspective of personality
and clinical psychology



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DOMESTIC FIRE, DOMESTIC SELVES

How keeping fire facilitated the evolution of emotions and emotion regulation

Terrence Twomey

Introduction

There is something about a domestic fire that stirs the emotions. Be it a hearth within the home or campfire in the open, fire evokes feelings of security, serenity, and belonging, and facilitates romance, meditation, and contemplation. In ritual, fire can mediate connections with ancestral spirits or allow specialists to transcend the phenomenal world. We cannot know if fire initiated such feelings in early humans, but we do know that they spent hundreds of thousands of years living with and keeping domestic fires. It is unlikely that our species, *Homo sapiens*, ever existed without fire.

This chapter investigates the emotional context of fire use in early human societies, using cognitive archaeology as a basis for the inquiry. Cognitive archaeology aims to explain prehistoric behavior in terms of the minimum necessary competence required to produce it (Coolidge & Wynn, 2016), or in this case the minimum emotional requirements. My focus therefore is not so much the aforementioned romantic ideals, but the basic emotional implications of prehistoric fire use. What were the minimum necessary emotional requirements associated with the domestication of fire? What kind of dispositions were needed to motivate and regulate appropriate behavior in a fire using society? The aim here is to provide some tentative answers to these questions by developing my ideas and arguments regarding the cognitive implications of controlled fire use (Twomey, 2011, 2013, 2014).

I propose that domesticating fire entailed regulating any emotions that would have undermined fire related behaviors and initiating emotions that motivated appropriate behavior at the right time. The practical demands of keeping fire and benefiting from it will serve as the basis of the investigation. From these considerations it is

probable that domesticating fire played an important role in the evolution of the human psyche, as it would have promoted prosocial emotions such as empathy and sympathy, and the capacity for emotion regulation, all of which are common characteristics of people today. Fire use would have fostered cooperation, cohesion, and civility among group members (Goudsblom, 1992; Twomey, 2014). It could also have favored positive relations between groups (Ofek, 2001).

The chapter begins with a summary of the direct and indirect evidence for fire use and proposes that regular fire use emerged in some human populations around the beginning of the Middle Pleistocene 800–400,000 years ago. This is followed by a discussion of the ecological and social conditions associated with the domestication of fire. I then describe the close relationship between the emotions and cognition, drawing on the history of psychology and recent developments in cognitive neuroscience. Evidence suggests that adaptive behavior in human society requires appropriate emotional responses, in conjunction with common sense reasoning (Mameli, 2004). The final section of the chapter relates human emotions to the practical problems associated with keeping, and benefitting from, a domestic fire, using cognitive archaeology to ground the discussion. In conclusion, I suggest that fire use could have played an important role in the evolution of human emotions.

The origin of domestic fire

Archaeological evidence for domestic fire

Archaeologists and anthropologists make a distinction between opportunistic fire use and controlled fire use, that is, between those who used fire when they came across it until it went out, and those who could maintain fire and access it with relative ease. My concern in this chapter is with controlled fire users. This does not necessitate that people could make fire but assumes that people could maintain fire for long periods and could access it from nature or other fire users when required. While it is possible to make reasonable estimates as to when controlled fire use emerged, unfortunately it is virtually impossible to know when fire making may have emerged in populations of fire users.

Knowing when controlled fire use became a regular behavior in human populations is a contentious issue. Some scholars favor a late emergence around 300–200,000 years ago or later (Dibble et al., 2017; Roebroeks & Villa, 2011a; Sandgathe et al., 2011), whereas others propose an earlier date about two million years ago or around 800,000 years ago (Alpersen-Afil & Goren-Inbar, 2010; Gowlett, 2016; Wrangham, 2009, 2017). While there is not much direct evidence for domestic fires prior to 200,000 years ago, there is good evidence of controlled fire use from some sites that predate this time.

At Tabun Cave in Israel evidence for domestic fire is in the form of flint items that appear to have been accidentally burnt by being discarded into hearths or having fires kindled on top of them (Shimelmitz et al., 2014, p. 198). Given the temperature to which the flints were heated and the location of them within the cave,

natural fire can be ruled out as the cause of heating. From about 350,000 years ago burnt flints are relatively abundant and a “constant feature of the assemblages” at Tabun Cave (Shimelmitz et al., 2014, p. 199). Similarly, Qesem Cave in Israel has evidence for extensive, repeated fire between 400,000 and 200,000 years ago (Barkai, Rosell, Blasco, & Gopher, 2017, p. S317). Recognizable hearths, recrystallized wood ash, large quantities of burnt flint and bone, and heated soil lumps that are associated with wood ash remains all indicated controlled fire use at this site. Barkai et al. note that “All the ash structures are related to wood burning and complete combustion” (2017, p. 218). The lithic assemblages associated with both these sites can be attributed to the Acheulo-Yabrudian Cultural Complex that appears in the region around 400,000 years ago. Both Tabun and Qesem Caves indicate habitual fire use by early humans over an extended period of time, not a single instance that could be interpreted as opportunistic.

The site of Gesher Benot Ya’aqov in Israel provides the earliest good evidence for habitual fire use. Alpersen-Afil and Goren-Inbar (2010) have conducted extensive research at this site and adopt a novel approach to identifying domestic fires by focusing on the spatial distribution of burnt flint microartifacts. By plotting the distribution of flint items heated beyond the temperatures reached in natural fires, the “phantom hearths” of Gesher Benot Ya’aqov have been made apparent (Alpersen-Afil & Goren-Inbar, 2010, p. 21). This evidence indicates that fire use is relatively constant at this site for about 100,000 years from around 790,000 years ago. The three Levantine sites discussed in the preceding text are significant because they indicate habitual fire use over extended periods, not opportunistic fire use as has been suggested for most Middle Pleistocene sites with evidence for domestic fire (Sandgathe et al., 2011). To date, there have not been any challenges or refutations to the interpretations given for fire use by early humans at these three sites.

Beeches Pit in East Anglia dates to around 400,000 years ago and has evidence for domestic fire in the form of burnt flints, many charred or calcinated small vertebrate bones, and dark fills with reddened adjacent sediments (Preece et al., 2007, p. 1281). While natural burning cannot be ruled out at this site, the concentrations of artifacts that are coincident with burning suggest domestic fire at this site. The areas of intense burning are spatially restricted and overlap, which unlike natural fires implies sequential burning at discrete locations (Preece et al., 2007, p. 1281). A refit of lithic material from this site shows that burnt flakes fit with unburnt flakes, which is highly unlikely to be the result of a natural fire and is suggestive of fireside knapping by the people who occupied this site (Preece, Gowlett, Parfitt, Brigland, & Lewis, 2006, p. 491). At Bilzingsleben in Germany dated to around 370,000 years ago concentrations of burned stone and charcoal are suggestive of hearths at this site (Mania & Mania, 2005, p. 100). There is strong evidence for controlled fire use in the form of burned materials that are spatially related to human activities and artifacts (Mania & Mania, 2005, p. 109). While Beeches Pit and Bilzingsleben do not indicate fire use over extended periods of time as do the Levantine sites discussed earlier, they do provide the earliest evidence for fire use in Northern latitudes. Fire would have been adaptive as a cultural buffer against the cooler temperate climates,

and the permanent occupation of northern Europe during the Middle Pleistocene may have required thermal buffers such as fire and clothing (Gilligan, 2010). The sites discussed in the preceding text provide good evidence for controlled fire use between 790,000 and 350,000 years ago and are listed below with some other sites with evidence of domestic fire predating 200,000 years ago.

- Wonderwerk Cave, South Africa – one million years ago (Berna et al., 2012)
- Cueva Negra del Estrecho del Río Quipar, Spain – 800,000 years ago (Walker et al., 2016)
- Gesher Benot Ya'aqov, Israel – 800–700,000 years ago (Alpersen-Afil & Goren-Inbar, 2010)
- Zhoukoudian, China – 780–700,000 years ago (Shen, Gao, Gao, & Granger, 2009; Boaz, Ciochon, Xu, & Liu, 2004)
- Qesem Cave, Israel – 420–200,000 years ago (Barkai et al., 2017)
- Beeches Pit, East Anglia – 400–350,000 years ago (Preece et al., 2007)
- Tabun Cave, Israel – 350,000 years ago (Shimelmitz et al., 2014)
- Bilzingsleben, Germany – 370,000 years ago (Mania & Mania, 2005)
- Orgnac 3, France – 300,000 years ago (Moncel, Moigne, & Combier, 2005)

Even if domestic fires were commonplace over the past million years we would not have much direct evidence for this, as clear evidence of fire will only be preserved in very favorable taphonomic conditions (Preece et al., 2007). Some scholars have argued if fire use were a common behavior prior to 200,000 years ago, then we would expect to find more evidence of it (Sandgathe et al., 2011). However, this is not the case, as we know of hundreds of Aurignacian (Roebroeks & Villa, 2011b) and Mesolithic (Sergant, Crombé, & Perdaen, 2006) sites where fire would have been used, but evidence for it is lacking. The claim that if fire were being used evidence of it should be present is simply not warranted given the poor preservation potential of burned materials. Therefore, the existing evidence for domestic fire during the Middle Pleistocene is particularly telling.

The cooking hypothesis

There is indirect biological evidence that regular cooking, and therefore controlled fire use, emerged much earlier than 200,000 years ago. The cooking hypothesis argues that traits associated with *Homo ergaster* and *Homo erectus*, such as a relatively larger brain and relatively small gut and mouth, are adaptations to eating cooked food (Wrangham, 2009, 2017). This situates the origin of controlled fire use at around three to two million years ago. A key issue raised by the cooking hypothesis is, how did humans of the Lower and Middle Pleistocene meet the increasing energy demands associated with their increasingly larger relative brain size? Scholars agree that for modern human brains to have evolved, the significant increased energy demands had to be met (Aiello & Wheeler, 1995; Mann, 2018). The expensive tissue hypothesis argues that you can increase the size of a metabolically expensive organ

such as the brain by reducing the size of another expensive organ such as the gut (Aiello & Wheeler, 1995). A reduction in gut size may have allowed for the increase in brain size associated with *Homo ergaster* and early *Homo erectus*, although their increased body size relative to earlier hominins such as *Homo habilis* means that the increased relative brain size in these hominins is not overly impressive.

The problem is that from about a million years ago until the emergence of the Neandertals and *Homo sapiens* around 300,000 years ago, relative brain size increases by an impressive one-third without any major increases in body size, and no apparent scope for any further reductions in gut size (Schoenemann, 2008). Therefore, the expensive tissue hypothesis cannot account for the most significant increase in relative human brain size that occurs in a relatively short period of time during the first half of the Middle Pleistocene. Something had to allow these humans to meet the increased metabolic demands associated with evolving, developing, and maintaining their big brains. The most probable explanation is that they had regular access to domestic fire and cooked much of their food (Herculano-Houzel, 2012).

Surviving on a raw food diet is extremely difficult for people today, even with access to mechanistic processing devices and very high-quality foods (Wrangham, 2009). The “Happy Cow” website tells us that even today the most dedicated raw foodists find it difficult to maintain a 100% raw food diet. In contrast, prehistoric humans did not have access to the foods and processing equipment that would allow them to maintain a raw food diet, by today’s standards. However, their daily energy demands were probably greater than the average person’s today. Seasonal food shortages are also common for people on a forager diet (Jenike, 2001). Critically, the people most at risk would have been pregnant women. According to Hockett (2012), the energy demands of a pregnant Neanderthal would have exceeded what could be obtained from a totally raw food diet. Cooking dramatically improves food quality because cooked food is easier to chew, digest, and metabolize than raw food (Wrangham, 2009) – thus, providing an important gain in energy obtained for the consumer.

Ignoring the issue of how small mouths and guts reduced the capacity of these humans to process and digest food, and accepting that maybe *Homo erectus* could have met their brains’ energy demands without cooking, one still needs to account for the almost one-third relative brain size increase that occurs from *Homo erectus* to the large brained humans of the Middle Pleistocene, such as *Homo heidelbergensis*, ourselves, and the Neanderthals (Du et al., 2018; Schoenemann, 2008). Based on genetic similarity, we could include the Denisovians here despite the lack of cranial fossils to indicate their brain size. Given the energy demands of neural tissue, and the limited means to meet these on a forager diet, the evolution of brains within the modern human range, during the Middle Pleistocene, requires explanation.

The best and most parsimonious explanation is that some humans had regular access to cooked food from the early period of the Middle Pleistocene (Herculano-Houzel, 2012). Genetic evidence suggests that the common ancestor of *Homo sapiens* and the Neanderthals lived around 630,000 to 520,000 years ago (Prüfer et al., 2017). In combination with the archaeological evidence for domestic fires, this

situates the emergence of controlled fire use in some human populations around 800,000 to 400,000 years ago. The taxonomic status of humans from around this time is not clear, be they classified as late *Homo erectus*, *Homo heidelbergensis*, early *Homo sapiens*, or early Neanderthals (Rogers, Bohlender, & Huff, 2017). However, it is likely that controlled fire use emerged in the population of these humans that led to the Neanderthals and ourselves. This does not entail that all populations of humans were fire users at this time, but those that were would undoubtedly have had a fitness advantage over those that were not. Thus, we can be relatively sure those that gave rise to *Homo sapiens* and our large brained relatives had regular access to cooked food.

Challenges to the cooking hypothesis

While there have been no strong challenges to the cooking hypothesis, many scholars still do not accept this date based on the lack of direct evidence for fire use by humans. There seems to be a null hypothesis of no direct evidence for fire then no fire, regardless of the implications the cooking hypothesis presents. If one argues that controlled fire use was not a regular behavior until after the evolution of *Homo sapiens* and the Neanderthals, then one needs to account for how these people met their energy demands on a raw food diet. The lack of a credible alternative to cooking is telling.

For example, it is possible that early humans had special processing techniques, such as curation, but there is no evidence for this. Perhaps some people had consistent access to very high-quality foods like ripe fruit, but we know that for most early human foragers this would not have been the case (Jenike, 2001). It may have been that these people had a different gut biome to us, with special enzymes for digesting raw foods, but there is no evidence for this. The most interesting aspect of the naysayer argument for early controlled fire use is that none of these explanations or others have been investigated. The energy problem of human brain evolution during the Middle Pleistocene tends to be ignored rather than accounted for. Until a better account is given, the best and most parsimonious explanation for how the energy constraints on evolving modern human size brains was met is that the last common ancestor of *Homo sapiens* and the Neanderthals had access to cooked food on a regular basis. To date no plausible alternative account has been provided. In the absence of a viable alternative hypothesis, we should be skeptical of claims (e.g., Cornélio, de Bittencourt-Navarrete, de Bittencourt Brum, Queiroz, & Costa, 2016) that the lack of evidence for early fire use implies that large human brains could have evolved independent of cooking.

The context of early human fire use

The focus of the following discussion is maintaining and using a campfire, rather than “fire stick farming” that is well documented in some contemporary human societies. Indigenous Australians, for example, use fire to manage and shape their

environment in complex ways and have done so for many thousands of years (Gammage, 2011). While this is an important aspect of fire use, we cannot know if the first fire users engaged in such behaviors. So, the focus of the chapter is hearth like fires or campfires that were maintained and used in a group context, assuming that food was brought back to the fire at a specific location, and consumed there after cooking, as is evident at Qesem Cave (Blasco, Rosell, Sanudo, Gopher, & Barkai, 2016). Rolland (2004) has argued that evidence for home bases in human societies begins to appear around 400,000 years ago and may be coincident with fire domestication.

Environmental contexts

By the beginning of the Middle Pleistocene human societies were geographically widespread, with people living in varied environmental contexts (Elton, 2008). By this time humans are living in tropical and temperate climates, which included both open savannah and dense woodland. The only environments without humans at that time were high altitude, arctic, and desert regions (Elton, 2008). This suggests that the first fire users overcame the different environmental challenges they would have faced. Some had to deal with scarce and distributed fuel resources, others with seasonal rain and damp conditions. Natural shelters were not always readily available (Ofek, 2001), and access to natural fire would have been seasonal and sporadic (Gowlett, 2016). These conditions placed a range of challenges that needed to be overcome for the domestication of fire to occur.

Controlling versus making fire

The first fire users would not have been fire makers, as the emergence of fire making practices presupposes a period of controlled fire use. While we cannot know how long it was before fire making emerged in any given population of fire users, it is reasonable to consider fire use in its absence as a basis for this investigation. Fire use most probably evolved through progressive stages whereby early humans first associated fire with some benefit and began taking advantage of naturally occurring fire. From this, people realized that a fire could be maintained and contained. Following this, early humans began to develop fire making techniques. This does not mean that there was some linear progression in this process, which probably occurred at different times and places throughout the Pleistocene. However, it is generally agreed that controlled fire use would have developed this way (Burton, 2009; Goudsblom, 1992; Gowlett, 2016). Therefore, it is probable that the first humans to become fire makers did so after an extended period of habitual fire use.

It is not known when or how fire making began. The earliest direct evidence for it dates to around 40,000 years ago (Stapert & Johansen, 1999). However, complex use of fire by Neanderthals during the Middle Palaeolithic and by *Homo sapiens* around 120,000 years ago suggests that fire making would not have been a cognitive challenge for these people (Koller, Baumer, & Mania, 2001; Wadley, Hodgskiss, & Grant, 2009), and probably emerged much earlier than 40,000 years ago. Anecdotal

and experimental evidence along with observations of apes in captivity and in the wild suggest that chimpanzees can master the basics of fire making and understand the basic properties of fire (Brink, 1957; Burton, 2009; Pruett & La Duke, 2010). This evidence also demonstrates that chimpanzees, like many trained and domestic animals, can overcome any innate fear of fire. This suggests that overcoming some of the cognitive challenges, and any basic fear of fire, may not have been particularly difficult for Middle Pleistocene humans. It is possible that the main constraint on the evolution of controlled fire use may have been overcoming the emotional barriers discussed in the following text.

Without fire making skills, accessing, maintaining, and protecting fire were necessary. Accessing fire would have been challenging for most early humans. In some environments natural fires are relatively common (Parker, Keefe, Herzog, O'Connell, & Hawkes, 2016), whereas in other contexts people may have had to rely on other fire users to gain access to fire. Ofek (2001) has suggested that the economic and environmental constraints on maintaining and accessing fire in the absence of fire making skills were such that specialist fire keepers who traded in fire may have been the only solution. However, Sorensen (2017) has argued that access to natural fires in Europe during the Middle Pleistocene may not have been as restricted as initially thought.

Practical context

Fire is useful in a variety of ways (Clark & Harris, 1985), but we cannot know specifically in most cases how early humans used fire. However, it is reasonable to assume that fire would have been used for cooking and warmth (Gilligan, 2010; Wrangham, 2009). There is evidence that fire was used in toolmaking (Aranguren et al., 2018; Koller et al., 2001; Wadley et al., 2009). However, this evidence occurs in the last 120,000 years, long after fire use had emerged. As such we can focus on cooking and warmth as these were probably the most adaptive and regular uses of fire for early humans. Using fire to ward off dangerous animals or to reduce parasite load would also have been possible, but specific evidence for this is lacking. In sum, cooking and warmth were probably the most adaptive and well-grounded uses of fire.

Social context

Early humans would have lived in small social groups of mobile foragers (Grove & Dunbar, 2012). While the size and constitution of Middle Pleistocene human societies are uncertain, surely these people had to negotiate a social world as do most primates. This would have impacted the ability of individuals to maintain and take advantage of fire. Individuals making decisions about provisioning, protecting, and transporting fire had to consider the intentions of others in the group toward the fire. The social context of fire use also meant that individuals had to consider how their behavior may have impacted the ability of others in the group to benefit from a domestic fire. For example, individuals may have been tempted to steal food from

others that was brought back to the fire. They could have tried to dominate the resource by not allowing others in the group to use the fire. They may have avoided gathering wood or tending the fire, but still used the fire, thereby benefiting from it while avoiding the associated costs. None of these behaviors are conducive to fire keeping in the long term, and, as discussed later, a real threat of punishment may have been required to discourage individuals from acting in these ways.

Today “all humans live in moral communities . . . in which public opinion . . . shapes the behaviour of individuals” (Boehm, 2000, p. 79). In human societies, wrong and right behaviors are defined by shared values, and it is the group that determines deviance and sanctions individuals accordingly. As Boehm points out, “These are constants of human social life, and on this basis a moral community engages actively in social control” (2000, p. 79). Scholars cannot be sure when hominin societies began to develop these human qualities. Fire use is important in this respect because it implies a degree of civility beyond that required for other early human behaviors and evident in primate societies (Goudsblom, 1992).

The psychology of emotions and cognition in humans

The received view in Western history is that the emotions or passions undermine proper reasoning and rationality (Mameli, 2004). Using reason, the will was believed to impose itself on irrational or improper impulses and motivations, thereby correcting behavior and understanding. While this view is still popular in folk psychology, philosophers of the sentimental enlightenment began to question this view in the eighteenth and nineteenth centuries. Adam Smith (1822) recognized the importance of empathy and sympathy in human societies. William James (1879) noted the link between cognition and emotion and the role emotion plays in philosophical reasoning. Hume (2003 [1739]) famously pointed out that reason is subservient to our passions and desires (Radcliffe & McCarty, 2018). Contemporary cognitive neuroscience and psychology support these insights (Coolidge & Wynn, 2009).

Emotions and cognition are deeply interconnected, and emotions largely govern proper behavior rather than thwarting it (Mameli, 2004). For example, people with prefrontal lobe damage or injury can have difficulty maintaining attention and regulating emotions. A key symptom in these people is a lack of caring and feeling toward people or situations. In most cases, people know that their responses or behaviors are inappropriate or lacking sensitivity, so the issue is not a cognitive one (Damasio, 2006). They lack the proper feelings and emotions that allow them to regulate or inhibit inappropriate or antisocial behaviors. In short, these individuals are easily distracted and have lost the ability to regulate emotions, stay focused on future directed tasks, and generate appropriate responses, which impacts negatively on themselves and those around them, as was the case with Phineas Gage (Coolidge & Wynn, 2009).

Emotion regulation and focusing attention on complex tasks are thought to be a function of working memory, which seems to organize and direct our executive functions (Coolidge & Wynn, 2009). This allows people to execute complex action

plans, often directed toward spatially or temporally remote goals, and enables appropriate behavior in social contexts. Humans feel, as much as know, social expectations through emotions such as shame, guilt, solidarity, and gratitude. This is related to emotional intelligence, which is monitoring the emotional states of others and ourselves, and being able to differentiate among them and utilize this information to direct and guide one's actions and thinking (Brackett, Rivers, Bertoli, & Peter, 2016, p. 513). This kind of intelligence is perhaps as important to our success as a species as our vaunted cognitive abilities.

Coolidge and Wynn (2009) have suggested that a small increase in the working memory capacity of *Homo sapiens* sometime between 130,000 and 60,000 years ago could have been the final step to modern thinking. However, while this may be true, the complex interdependence of cognition and emotion in the human psyche today presupposes that human emotions have coevolved with our cognitive abilities over a long period of time. There is no reason to infer from either the evidence or common sense that we miraculously shifted from ape like thinking to human cognition and sensitivity in one punctuated step as has been suggested (Tattersall, 1999). Our ancestors were most likely already thinking and feeling in human-like ways before any final transition could have occurred. As Papagianni and Morse suggest while considering the success of *Homo heidelbergensis*, "In Europe, half a million years ago, there was an intelligent, capable and even *sentimental* form of humanity" (2015, p. 51, *emphasis added*).

This raises the question of what behavioral contexts would have favored the development of working memory capacity, sentiments, and an increased capacity for emotion regulation in humans at this time. This is where fire comes in. Domesticating fire would have presented early humans with emotional and cognitive challenges that had to be overcome to take advantage of fire's benefits. As I have discussed the cognitive implications of fire use at length previously (Twomey, 2011, 2013), the focus in the following text will be on the emotional implications.

The emotional implications of domesticating fire

Provisioning fire

A feature of the relationship between the emotions and cognition in humans is that these combine to motivate behavior directed at remote goals (Koole, 2009; Mameli, 2004). We aim to satisfy or avert future outcomes by acting in the present. This requires not only cognizing desired outcomes, but also having sufficient positive or negative emotional associations with them. Individuals not only need the drive to undertake a future directed activity, but also need the ability to overcome or ignore feelings that may interfere or conflict with future directed action plans. Most behavior in other animals is of a different character in that it is primarily or largely directed at proximate goals. When animals do engage in future directed behaviors such as migration or food caching, it seems to be mostly governed by hormonal releases that initiate the appropriate emotional motivations, rather than cognitive

triggers (Shettleworth, 2010). Humans know what they want, and this understanding seems to suffice to generate the appropriate desires at the right time. Human desires are also more complex than those of other animals that seem to focus primarily on survival, subsistence, and reproduction.

Fire use presented early humans with a motivational problem in this respect. People needed to gather fuel to keep the fire going so that the fire was ready to use when required. They also needed to have sufficient fuel available so that the fire could be used for cooking or keeping warm at night. This means that fuel would often need to be gathered in advance of using it because the fire might need fuel at times when gathering it was not practical, like at night, or because all proximate fuel supplies would have been exhausted. As Ronen has pointed out (1998, p. 443), provisioning a fire is a detached system, in that the connection between action and reward is removed in time and space from the future benefit that fuel gathering provides. While toolmaking may be similar in some respects, in most contexts individuals could have made or retouched tools as required. Also, much fire related activity would have been directed at the secondary aim of keeping the fire going, not the primary aim of using it for some purpose. If people needed the fire at night, then it needed to be kept going during the day when it was not in use.

A further difficulty with fuel gathering is that it is a mundane task. It is not necessarily the sort of activity an early human, or any human, might choose to do without strong motivation when compared to seeking food or mates, or just lazing around grooming. From the fact that the first fire users could gather fuel, it can be inferred that they had strong desires directed at cooking or being warm at night, and that they could overcome any proximate desires that otherwise would have prevented them from gathering sufficient fuel supplies. This suggests the presence of emotions motivating future directed behavior, and a relatively well-developed capacity to regulate inappropriate or conflicting emotions, which is indicative of an improved working memory capacity not evident in other early human activities. If individuals were always being distracted from fire related tasks by more immediate rewards, then these tasks would not have been done, and the fire would have gone out.

Maintaining a domestic fire also implies intersubjective understanding. Individuals in the group would need to understand the intentions of others toward the fire, such as who was gathering fuel and who was maintaining the fire. This would have been required to avoid awkward situations arising, like everyone returning to the fire with food, but with insufficient fuel to cook it. Intersubjectivity is a prerequisite for language evolution (Tomasello, 2008) and for the evolution of empathy and sympathy toward others, which provide an important emotional foundation for the existence of human societies today (Preckel, Kanske, & Singer, 2017; Smith, 1822).

The social constraints of domestic fire

A campfire in the open or a cave was effectively a public good for early humans (Ofek, 2001; Twomey, 2014). Individuals within the group, or outsiders, could have used it as an ignition source, avoiding the cost of ongoing maintenance, or simply

used it to cook or keep themselves warm. Without active interventions there was nothing to prevent freeriding. However, unchecked freeriding in a fire using society would have presented these people with a big problem to overcome. As Ofek has pointed out (2001, p. 160), public goods encourage freeriding, but this would not have been viable as eventually this leads to only freeriders, no fuel gatherers, and no fire. This problem would have been compounded if stronger individuals tried to steal food brought back to the fire and restrict the access of others to the fire. The difficulty here was that individuals will not provision a fire that they cannot use, and individuals would struggle to dominate and maintain a fire on their own. As Rossano has pointed out in a personal communication, there is a clear punishment for all if the fire goes out; therefore the cost of freeriding would have been clearly seen and felt by all in a compelling way. Sterelny notes (2007, p. 722) that social norms would have been advantageous in this context because they make social expectations explicit and unambiguous, and failures to cooperate negatively marked and salient.

In many primate societies dominant individuals try to control access to resources (Dunbar, 2004). Given that today about one-third of people will freeride if they can (Kurzban & Houser, 2005), and that public goods like roads can only be maintained through enforced taxation (Ofek, 2001), there is no reason to think this would not have been a concern in early human societies. As mentioned earlier, the problem is so great that Ofek (2001) suggests only an economic solution of specialist fire keepers who traded in fire would have sufficed to solve the problem of freeriding. However, passive or active cooperation supported by human prosocial emotions could have restricted the problem of freeriding.

Individuals could have cooperated passively, by contributing to fire related tasks and allowing unrestricted access to the fire. They could also have cooperated actively by punishing or excluding freeriders or dominant individuals from the group. The benefits of fire are significant and may have provided the additional incentive needed to encourage individuals to team up against freeriders and bullies. There is evidence that early fire users overcame the freerider problem in the form of food sharing and unrestricted access to the fire for cooking (Blasco, Rosell, Sanudo, Gopher, & Barkai, 2016). This also implies that individuals were able to delay the consumption of food that was transported back to a home base.

From this we can infer that the basic emotions supporting cooperation would have been in place in a fire using society. A greater capacity for emotion regulation would have allowed individuals to avoid temptations to cheat the system. Alternatively, the development of social norms that were enforced through punishment would have been adaptive. In these kinds of contexts, emotions such as guilt or shame and those encouraging solidarity would have assisted humans in working together. As with provisioning fire, human empathy would have been adaptive in fire related cooperation, as this plays a key role in supporting caring attitudes and altruistic behaviors in human societies today (Slote, 2009).

Conclusion

In conclusion, the delay between fire related behaviors and their intended outcomes and the social nature of controlled fire use demanded an enhanced degree of emotion regulation and motivating emotions relative to other early human activities. Similarly, the delayed consumption of food implies an enhanced degree of emotion regulation relative to other primates. In combination with subsistence strategies and tool use, controlled fire use made the ecology of early humans far more complex. Prosocial emotions that facilitated passive and active cooperation would have been advantageous in a fire using society. Freeriding and efforts to dominate resources would need to have been minimized or eliminated through emotionally salient social norms, and perhaps through a genuine threat of punishment. Even when considering only the basics of provisioning a fire and using it in limited ways, domesticating fire implies some fundamental human capacities of emotion regulation and motivation directed toward attaining remote goals. As Goudsblom (1992) has argued, domesticating fire would have involved a civilizing process that entailed human-like feelings and prosocial attitudes toward the fire and each other.

The domestication of fire most probably had a big influence on the evolution of human cognition. As Rossano (2007) has suggested, fireside rituals may have been influential in this regard. Even at a basic level fire would have required enhanced cognitive capacities and increased emotional sensitivity and awareness. Importantly, fire use by early humans is indicative of an enhanced working memory capacity and greater sensitivity to one's own emotions and the emotions of others. It is important that we do not single out any one feature or behavior as the prime mover of human evolution; our species, no doubt, is the result of a complex web of activities and biological proclivities. That said, I believe a strong case can be made that fire use would have played an important role, as it demands both cognitive and emotional characteristics that are distinctively human. In a very real sense we are all children of the flame.

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23

PSYCHOLOGY IN ARCHAEOLOGY

The secret society case

Brian Hayden

Paleopsychology is not archaeology.
Anonymous reviewer

Human nature

If human nature is relevant to archaeology, to what extent can the development of culture be attributed to our distinctive psychological traits? Some early ethnologists in the 1860s, like Adolf Bastian, argued that the “psychic unity of mankind” was genetically based and was essential for understanding fundamental cross-cultural patterns in behavior including music, art, language, kinship, belief in spirits, and even common regional patterns like the use of shell beads. Such concepts have remained in the background of anthropological thought for the past century, but laid the foundation for Joseph Campbell’s comparative mythology and Carl Jung’s ideas about the collective unconscious and archetypes. Here, I would like to argue for the importance of a particular aspect of human nature – common human motivators and personality characteristics – in understanding key developments in cultural evolution. The basic argument is that emotions are major motivators in human behavior and need to be incorporated in models of past human behavior. However, before delving into specifics, I would like to explore the nature of this “psychic unity of mankind” (a.k.a. “human nature”) and provide a framework for the following discussion. Some of my thoughts about the evolution of personality characteristics and emotions were first formulated 30 years ago (Hayden, 1987). Subsequently, I restated the argument:

While many people think of intelligence as the most distinctive and successful evolutionary development in humans, the unique emotional

transformations that humans underwent were no less critical to our survival and success. In fact, these emotional characteristics constitute the very core of human nature.

(Hayden, 1993, p. 161)

The major premise of my early argument was that intergroup and intragroup alliances became critical for survival on the African savannah in the Lower Palaeolithic. The techniques that evolution selected to create strong emotional bonds between individuals to ensure commitments to such alliances probably included kinship, rhythm, music, singing, dancing, drama, humor (smiling and laughing), gift giving and materialism, visiting, a sense of magical mystery or supernatural beliefs, altered states of consciousness, and sacred ecstatic experiences (SEEs) involving higher entities (Hayden, 1993; Brown, 1991; see also Hayden, 2003). Natural selection must have played a key role in making the necessary genetic changes effective in developing these proclivities and the emotional responses to them. Other animals simply do not have such capabilities, or at best only express them in very rudimentary ways. I contended that the only selective pressures strong enough to make these emotional characteristics pervasive in human populations would have been related in some fashion to survival advantages.

Establishing alliances to provide access to resources when needed, and hence for survival, is possibly the best scenario to account for such changes, something that I referred to as the development of a “social technology” founded on genetically determined emotional reactions to kin, music, ritual, and other triggers. It is gratifying to find that others have also recognized the important role of emotions in archaeology, especially for human evolution and in defining human nature (Cowgill, 1993; Gamble, Gowlett, & Dunbar, 2011; Gowlett, Gamble, & Dunbar, 2012; Tarlow, 2000), and to see so many researchers viewing the emotional differences between humans and other species as genetically based (see also Bloch & Sperber, 2002; Hare, 1993).

For me, it is impossible to understand past human behavior without understanding human emotional and personality foundations, including their variability. Some of the most obvious archaeological manifestations of emotion-related behavior may involve regional interactions, prestige items, ritual structures, art, masks, and other symbolic materials. The distinctive constellation of people’s emotions constitutes what can be called “human nature” only at the population level, not on the individual level. As can be readily appreciated, there is great variability in human emotional and personality expressions. Not everyone holds kin near and dear; not everyone believes in spirits or responds to music or any of the other usual emotional triggers. But such variability is not unique to the human psyche. It also typifies physical characteristics. Are people with amputated limbs or severe birth deformities not considered human, even if their dexterity, intelligence, or linguistic abilities are impaired? Indeed, it is a daunting task to come up with any universally applicable definition of human beings whether based on intelligence, cognition, emotions, or physical attributes. Exceptions can always be found on an individual basis. Nevertheless, it is

the aptitudes for, or appreciation of, rhythms, singing, ecstatic experiences, or other emotions (together with linguistic and intellectual abilities) that differentiate people most from other species. And the emotions responsible for these behaviors are found in large proportions of virtually all human populations. No other animals use these techniques in the same way.

Given the definitional conundrum posed by individual cases that do not conform to specific criteria, I suggest that a polythetic definition of humanness is essential. Polythetic definitions involve a series of distinctive traits in which no one trait is critical for membership in a class or taxon; rather a majority of traits is sufficient to be included in a taxon. This is a common way to classify many things in our environment, as well as to classify artifacts like bipolar cores or billet flakes (e.g., Hayden & Hutchings, 1989). I would argue that it is also the way we define individual humans in relation to other species. Individuals who lack the ability to communicate or think analytically or walk upright are still considered humans on the basis of all the other characteristics that they share with those recognized as human, even though any one (or more) “critical” physical or mental characteristic may be missing. Human emotions are considered to be such critical characteristics. It is the specific constellation of emotions that makes up the distinctive human nature of populations, even though individuals may be deficient in one or more (perhaps most) characteristic human emotions. From this emotional perspective, intelligence, physique, and tool use could be considered more like epiphenomena of human evolution – largely the result of the importance of adaptations based on social relationships (Dunbar, 2003, Gowlett et al., 2012). In the list of one’s own personal priorities, what is more important: the ability to use tools or affection for one’s children? The ability to walk or the ability to create art? The ability to talk or the ability to experience rapture?

Key human personality traits

When we turn to specific human psychology traits that may be related to cultural developments, we find that evolutionary psychologists and anthropologists have discussed human personality traits rather extensively. In addition to aptitudes or orientations in terms of the emotions already mentioned, distinctions have been made along the dimensions of optimism–pessimism; work–play; pleasure–indolence; cooperation–competition; altruism–self-interest; aggression/charisma–passiveness; depression–activity; superstition–rationality; manipulation–honesty; leadership–follower; sex preoccupations–asexual interests; power–submission; materialism–non-materialism. There are many other personality traits that can be added. The key question is: Which of these personality traits or motivating emotions might be critical to understanding prehistoric cultural changes? Trait theorists in psychology variously claim that all personality traits can be distilled down to 3, or 5, or 16 fundamental factors or dimensions (Costa & McCrae, 1992; Eysenck, 1967, 1991; McCrae & Costa, 1987; Reiss, 2000).

Given the wide range of potentially important personality traits, it is interesting to contemplate the possibility that if the most distinctive human psychological

characteristics evolved as part of a social technology to bind people together emotionally for the good of the group, then the motivation to focus on individual advantages – leading to power pyramids – would have had to come from individuals who exhibited minimal or none of the distinctive human emotions but who might be capable of manipulating them. The extreme expression of such asocial traits occurs in individuals who are commonly referred to in industrial societies as sociopaths or psychopaths. Robert Hare (1993) has devoted most of his research into the trait complex exhibited by sociopaths and psychopaths. They form a very distinctive personality trait and motivational complex. What makes them so distinctive is their lack of normal human emotions other than those that involve their own self-interests, independence, and sense of power. While they can be remarkably charming or seductive, empathy for other people is completely lacking, and they exhibit an unrelenting drive to satisfy their own desires and need for control irrespective of the cost to other people. They are often intelligent, garrulous, and master imitators of normal human emotions in highly manipulative schemes to benefit themselves. To achieve their ends, they manipulate the normal human emotions in others, including supernatural beliefs, materialism, desire for social or sexual interactions, proclivities for entering altered states or consuming social drugs (e.g., alcohol), and moral feelings surrounding commitments and debts. They target lonely and insecure people and often push psychological buttons just to see reactions. Their self-image is typically defined by material possessions and symbols of power and success (Hare, 1993; Kiehl and Buckholz 2010).

I cannot tell whether such individuals were extreme outliers in the statistical factor analyses used to distill the 3–16 personality trait dimensions of psychologists (and hence such individuals would not have been included in their statistical models), or whether such individuals were included at the extreme end of the “extraversion” personality dimension associated with assertiveness and high activity levels. In general, Hare estimates that sociopaths consistently form about 2–3% of populations. Yet, as we shall see, such characteristics were plausibly the driving force behind the developments in prehistory of socioeconomic inequality, political centralization, hierarchies, sociopolitical complexity, and related traits. It is difficult to derive these characteristics from community-minded altruistic individuals, although there is no lack of archaeologists who have tried (most recently, Stanish, 2017).

There are several features about sociopaths and psychopaths (and even those with similar but less extreme personality characteristics) that make them of exceptional importance for understanding past cultural changes. The key characteristics of sociopaths that can account for cultural changes are: First, they are part of normal genetic variation in all human populations. The sociopathic extreme may only constitute 2–3% of most populations (somewhat more if we include people with such tendencies but who are not identified as sociopaths). Second, they pursue their self-interests irrespective of consequences to others. Third, they are active, persistent, and unrelenting in pursuing their self-interested goals. Fourth, they are attracted to power and control. Fifth, they are prone to deceptions and manipulation of people (often feigning charisma and affability) in social situations to achieve

their ends. And sixth, they are extremely inventive in devising strategies to achieve their goals.

Margaret Mead is reputed to have said, "Never doubt that a small group of thoughtful, committed people can change our world; indeed, it is the only thing that ever has." She undoubtedly had a more idealistic notion of change in mind, but sociopaths constitute just such a small group of committed people who gravitate to positions of control, whether in business, politics, or religion; and they unrelentingly promote policies that favor themselves and the exploitation of others.

I have argued that when subsistence was difficult – as it must have been during most of the Pleistocene – group survival took precedence over all else, and individual interests (e.g., aggrandizing schemes) were subordinated to group needs, if not entirely eliminated, especially where food was involved. Aggrandizing behavior (including sociopathic and less extreme pursuits of self-interests) was not tolerated by the majority, and social sanctions or physical removal of non-conforming individuals eliminated such behavior. Nevertheless, self-interest is the foundation of Darwinian natural selection and would have been impossible to completely eliminate, in addition to which maintaining some aggressive self-serving individuals in the gene pool may have helped groups survive during episodes of lethal conflicts with other groups. When subsistence became more abundant (due to natural factors or improved technologies), survival based on food security would have been no longer significantly threatened, and individual idiosyncrasies or some self-interests could have been tolerated, including some aggrandizer schemes based on the use of excess foods. The advent of storage, in particular, generally meant that people had left-over "buffers" that could be used as surpluses in gambits for achieving political and social goals without threatening the food security of others (Halstead, 1989, 1990; Testart, 1982).

In fact, we begin to see a range of subsistence-based aggrandizer strategies appearing in the archaeological record with the first indications of storage and surpluses, specifically in the Upper Palaeolithic and Mesolithic (or the Archaic Period in North America and Epipalaeolithic in the Near East). Secret societies do not appear to have existed among generalized or simple hunter-gatherers, but were ethnographically common among complex hunter-gatherers with significant storage and surpluses such as many ethnic groups in California and the Northwest Coast of North America. In the ethnographic cases, secret societies occurred together with other profound differences from simple hunter-gatherers in subsistence and material culture (e.g., prestige objects). There were also major differences in social structures, with complex hunter-gatherers being differentiated from simple foragers by hierarchies and even slaves, costly marriages and funerals, the establishment of burial areas, feasting, wealth and power inequalities, claims over resources based on degrees of training or ritual knowledge, imposition of fines or punishments for transgressing a wide and capricious roster of ritual prescriptions and proscriptions, new ideologies featuring ancestors and other entities, intensified warfare (up to 25–30% violent mortalities), recognition of private property, and increased sedentism with substantial architecture. Thus, secret societies constitute only one element – but an important one – of what

I consider to have been the most important cultural transformation since the inception of the hunting and gathering way of life several million years ago (Hayden, 1995, 2001, 2014). Agriculture was arguably only a footnote to this transformation. Many horticultural and agricultural communities continued to support secret societies, with some of the most notable examples located in the American Southwest and Plains, among West African chiefdoms, and in Vanuatu, Melanesia (Hayden, 2018).

I have argued that this major cultural transformation from simple to complex hunter-gatherer societies cannot be understood without considering human motivations and personality types. The recurring common element behind most or all of the aforementioned changes is the promotion of self-interests by individuals who stood to benefit from them, i.e., by aggrandizers including sociopaths. Sillitoe (1978) has shown how aggrandizer big men manipulated warfare for their own benefit. I have shown how aggrandizers manipulated people by using feasts for their own benefit (Hayden, 2014) and that domestication closely followed the development of feasting (especially with domesticated animals accompanied by beer and bread, all primarily used in feasts). Many of the other transformed cultural aspects display self-evident self-interests (holding slaves, acquiring wealth, private property, ancestor cults, wealth-based marriages, prestige items, many ideological changes), or are causally linked via the need to produce surpluses (storage, sedentism). It is not so obvious how ritual might be related to the pursuit of self-interests by aggrandizers or how it could have constituted one of their strategies. Thus, I will examine this aspect in more detail. Specifically, I will look at: (1) the motives, goals, and purposes of secret societies together with the personality traits of their leaders and (2) the strategies used to achieve their goals.

Secret societies as aggrandizer strategies

While there were a number of major strategies used by aggrandizers to achieve benefits for themselves, secret societies should occupy a special place for archaeologists because of their relationship to ritual behavior and the important role of ritual remains in the archaeological record, ranging from the painted caves of the Upper Palaeolithic to the great ziggurat temples of Sumer. Because few people outside of specialized ethnographers are familiar with secret societies, I will first define them and discuss some of their most important characteristics, then relate aggrandizer personality types and their motivations to typical secret society leaders.

The secret

Secret societies among tribal, transegalitarian, and chiefdom societies were voluntary, ranked ritual associations whose memberships – or at least the upper ranks of memberships – were exclusive and who typically claimed to possess secret ritual knowledge of great value to their own members or which could be used for the benefit of others, usually at a cost. Contrary to what many people imagine, the secrets in secret societies were not that the societies existed or who belonged to them. Instead, the secrets consisted of ritual (or other) secrets that were claimed to

affect people's health, success, welfare, survival, and even the cosmic order. The most profound secrets were only known by the top-ranking officials of each secret society. Secret societies generally put on public performances and feasts to demonstrate their arcane powers. In order to obtain access to the ritual knowledge of the societies, initiates characteristically paid high admission and advancement fees that required giving substantial wealth payments and feasts to the society. As such, the leaders of secret societies sucked up large amounts of surpluses from new or advancing members and their families or those willing to provide loans to aspiring members. Because of these heavy demands on surplus production, secret societies were only found in areas where significant amounts of surpluses occurred. While secret societies generally claimed to undertake rituals for the benefit of their communities, they alternatively terrorized communities with displays of putative unleashed spirit powers. As will hopefully become evident, the underlying motives of secret society leaders was to increase their own benefits, wealth, and power. Kinship organizations like lineages and clans limited the extent to which ambitious leaders could extend their power. In contrast, secret societies provided an effective way of transcending kinship and even local constraints by incorporating wealthy leaders from multiple kinship groups and usually other local communities, thereby establishing regional ritual networks (see Hayden, 2018).

Can secret societies be identified in archaeological remains? They certainly can due to the distinctive sizes, locations, and architecture of ritual meeting facilities; distinctive ritual paraphernalia (masks, whistles, bullroarers, costumes); distinctive iconographies featuring aggressive power animals; the development of esoteric knowledge (especially, astronomical systems as represented by structures with solar alignments); distinctive burials; the common use of human sacrifice or indulgence in cannibalism; and the existence of regional ritual networks sharing all these features among other features (Hayden, 2018).

Motives, ideologies, and techniques

Ethnographers rarely discuss the motives and goals of the traditional people that they study. However, some insightful comments do exist in the literature on secret societies. I will first present what has been said about the motives and personalities of leaders and members of secret societies in a variety of classic studies including the benefits that members sought, and then I will discuss the ideological claims that emanated from secret societies as well as the means used to obtain compliance from other community members.

Motives and personalities

Northwest Coast

Some of the most classic studies of secret societies come from the North American Northwest Coast. Drucker (1941, p. 226) categorically stated that the function (i.e., motive) of secret societies was to dominate society by use of violence and

“black magic.” Members experienced powerful feelings of superiority (McIlwraith, 1948b). Powerful chiefs were members of these secret societies, and they “feared no restrictions and heeded no convention” (McIlwraith, 1948a, p. 489). Their power was reputed to be unquestioned at the time of contact (McIlwraith, 1948b). They received many lavish material benefits in terms of payments for services (e.g., curing), and as sponsors for initiations

California

California also harbored secret societies in many regions. While little is reported about motivations for this area, it is clear that members – especially leaders – benefited substantially from payments for dance performances, curing, or other services, and for ensuring that the world order continued.

The Southwest

In the southwestern Pueblos, leaders of secret societies (a.k.a. “ritual sodalities”) were also highly compensated via food, feasts, and ritual paraphernalia, for their ritual and curing performances. Tellingly, as on the Northwest Coast, leaders of secret societies enforced their will on disenfranchised community members (Brandt, 1977; 1980, pp. 126–128, 141).

Great Plains

On the American Great Plains, it is reported that joining medicine bundle (secret) societies was for the elevation and pleasure of the members (Fortune, 1932; Murie, 1916). Members of the Water Monster Society were taught to get wealth and take whatever they wanted (Fortune, 1932). Those belonging to the Dog Society could do “whatever with whomever” they wanted, while those in the Stone Hammer Society could take whatever they wanted (Lowie, 1916). Members of the Doctoring Society were reported to make people sick so that they could obtain large fees for curing them (Fortune, 1932). Members were described as “rapacious” and “extortionists.” As Fortune (1932, p. 86) stated it:

The power members had was not exercised for any social function but for their personal aggrandizement. They collected sheer “graft” freely, not only profiting by illnesses and the popular conviction that doctors could turn illness into death at will, but also collecting in advance on occasion.

Ambitious members were reported attempting to kill rivals to protect their financial interests, or even being willing to see family members die so that power could be acquired in secret societies (Fortune, 1932). Given these observations, it is not surprising to find that Fortune described the public personas of leaders of these societies as friendly and demure, while in private they were appallingly arrogant. This is a

recurring pattern and probably typifies secret society members everywhere as well as more contemporary aggrandizers who appear generous and altruistic “in the light” but undermine others’ interests “in the dark” (Maestriperi, 2012).

Great Lakes

In the Great Lakes area, the Midewiwin secret society was established “to give a certain class of ambitious men and women sufficient influence through their acknowledged power of exorcism and necromancy to lead a comfortable life at the expense of the credulous” (Hoffman, 1891, p. 151). The “influence wielded by mide [members of the society] generally, and particularly such as have received four degrees, is beyond belief” (Hoffman, 1891, p. 274). Their influence approached deity status. Tellingly, initiates were taught that they needed great strength to resist doing evil, which implies that there were many who could not resist such temptations. Aside from the usual material benefits of food, feasts, and ritual items, members were paid large sums to kill or cause misfortune to others, or to procure benefits for clients.

Melanesia

In Melanesia, on the New Hebridian island of Malekula, secret societies were particularly well developed and conferred great economic and power benefits to members resulting in keen competition among leaders (Speiser, 1996). The “earthly advantages” of these societies “impel a man to seek promotion in ranks” (Speiser, 1996, p. 372) with the goal of extending their influence and augmenting their wealth. New initiates had to borrow heavily from senior members for admission to these societies. Taking full advantage of this situation (which they had created), high-ranking members in the secret societies “ruthlessly squeezed debtors dry,” and creditors acted despotically on the basis of the supernatural powers that they claimed to have (Speiser, 1996, p. 249). High-ranking members also terrorized others to get what they wanted, using intimidation, robbery, and even murder.

It is belief in the potent mana of men of high rank which gives them their esteem and they exploit this belief in every possible way in order to indulge in whatever may be to their advantage and profit.

(Speiser, 1996, p. 356)

As Speiser (1996, p. 250) phrased it, high-ranking men had “outstanding but not admirable personalities.” To augment their benefits beyond the exorbitant initiation fees, members sold amulets, ritual knowledge, or songs, and they tabooed important resources for their own use. During the rituals of the secret societies, there was:

great license in carrying off all they want, robbing gardens and stripping fruit-trees for their feast and then any one will suffer who has spoken or acted without due respect to the society. The ghosts in their disguise will

rush into the villages, chasing the terrified women and children, and beating any whom they can catch.

(Codrington, 1891, p. 83)

West Africa

West Africa was also an area where secret societies developed to a high degree, notably in the context of chiefdoms. As in other areas, the *Poros* secret society was used to dominate and rule others (Walter, 1969). It “was a place where human ambitions used spirit powers for selfish ends. The final secret of the *Poros* was frightfulness” (Harley, 1941a, pp. 7, 18). The “men’s whole concern was to keep the women and children terrified and to use the higher knowledge of the inner circle of priests for selfish ends” (Harley, 1941a, p. 18). The “control of tribal affairs rested in the hands of a few privileged old men of high degree in the *Poros* who worked in secret and ruled by frightfulness” (Harley, 1941a, p. 31). The motives for forming some secret societies verged on the macabre. The Human Leopard Society, the Human Crocodile Society, the Python Society, and the Baboon Society had the avowed goals of renewing members’ vigor and youth through human sacrifices and cannibalism. Similarly, the Sorcery Society used spells and cannibalism to benefit members or openly demanded sex, or they stole what they wanted (Harley, 1941b). Material benefits resulted from payments for services and initiations, from fines for transgressions of the society’s many rules, and from cures of people whom they had made sick (Harley, 1950). Members also put taboos on resources they wanted for themselves, imposed tolls on travelers, and monopolized the valuable palm oil production. Masked spirit impersonators begged, borrowed, extorted, or stole so much food for their rituals that it became “a serious drain on the public wealth” (Harley, 1941a, pp. 8, 16–17). Masked spirit dancers always had to be compensated with food and gifts. As on Malekula, the power and wealth benefits of membership created intense rivalries resulting in attempts by leaders to poison each other.

Ideological claims

In order to justify the sometimes shocking behavior and privileges that secret society members claimed as their right, I suggest that they formulated new ideological systems (sometimes based on earlier local concepts or myths) that they promoted and demanded acceptance of, or acquiescence to. These new ideological systems and their components often can only be interpreted as serving the interests of secret society members. While a certain portion of the population undoubtedly accepted such claims without question, others probably could be swayed to accept or comply with these claims through the use of dramatic demonstrations of supernatural powers by secret society members as well as through applying social and economic pressures. However, there must always have been a skeptical or recalcitrant portion of the communities who refused to accept such self-serving ideological claims. These individuals were dealt with harshly if they expressed any sign of “disrespect” or intrusion into the society secrets, as indicated earlier and as will be seen in the following text.

I wish to argue that it was the leaders of the secret societies who formulated and promoted these new ideologies.

General aspects of these new ideological systems include claims of special connections with powerful supernatural entities (often ancestors, totems embodying ancestors, or ancestors who received powers from higher level powerful spirits). In the new ideologies, dealing with these powerful supernatural entities required appropriate ancestral connections, wealth, knowledge, and ritual performances. The power of these entities was portrayed as dangerous, so that contact with them required special training, knowledge, paraphernalia, and rituals. Lack of control of these supernatural powers could be disastrous for communities, whereas control of these powers could confer good weather, good harvests, wealth, health, success, and wellbeing, but could also be used to kill.

Northwest Coast

On the Northwest Coast supernatural powers were originally said to have been acquired from powerful beings by some remote ancestor who passed on the ability to access those powers to worthy descendants who could pay for the paraphernalia and training needed to control the power. In addition, material success as well as political positions of power, according to the ideology, were due to the ability to access the supernatural powers via the performance of appropriate rituals and feasts. People without such qualifications were labeled as incompetent and incapable and therefore ignored. It was claimed that no success in endeavors was possible without supernatural help and the use of proper rituals (Adams, 1973; McIlwraith, 1948a). However, these supernatural powers were dangerous, as were those who could access such powers, hence the need for arcane knowledge and rituals. These powers included the ability to kill people and bring them back to life, or to capture people's souls, which were returned for a fee. In the publicly expressed ideological rhetoric, supernatural powers were used to protect the community from dangerous spirits (among others: cannibal spirits, breakers, and destroyers), diseases, and other misfortunes, and members of the secret societies claimed that only they had the knowledge to protect people.

California

Similarly, the ideology promulgated by secret societies in California portrayed supernatural power as dangerous but necessary to deal with for success and to maintain the world order (Hudson & Underhay, 1978). Even luck was conferred as a supernatural favor for the performance of proper rituals. Natural disasters occurred because of improper human behavior (presumably anything that acted against the interests of secret societies), and order could only be restored through special rituals known only to secret society members (Bean & Vane, 1978). Secret society leaders took the credit for good harvests, good weather, cures, enemy deaths, and protection from dangerous spirits and animals such as bears (Dixon, 1905). Thus, they claimed to provide essential benefits to the community. Presumably this was the justification

for demanding material and non-material support from the entire community. All the behaviors of secret society members were justified on the basis that their spirit allies demanded such behavior, which if not followed would result in the death of the individual who channeled that spirit (Dixon, 1905). Another self-serving claim of Chumash secret society ideology was that any affront to the chief (a member of the “*Antap* secret society”) put the village in jeopardy and therefore the transgressor had to be punished (Boscana, 1933).

The Southwest and Plains

The secret societies of the Southwest and Plains similarly claimed that their purpose was to help and protect the community in war, in weather and harvests, in curing, in hunting, and in other domains (Ware, 2014). Masks, paraphernalia, and medicine bundles were very expensive to obtain. Protection of warriors was an especially important function on the Plains; crops and buffalo herds were also supposed to be controlled by secret societies (Lowie, 1916). To do all these things, various “mystical powers” had to be supplicated, and secret societies claimed that only they had the knowledge and ability to do so (Bailey, 1995). Supernatural influence was via animal patrons, ancestors, or sacred bundles, all of which required special paraphernalia, knowledge, and rituals. Supernatural power was dangerous so that even spectators at supernatural demonstrations were at risk and had to be kept at a distance (Fortune, 1932). Owners of bundles had to be avoided during travels due to their dangerous powers. Secret societies also promoted the idea that high-ranking members could transform themselves into various animals, especially bears. This was an ideological feature of Ojibway secret societies around the Great Lakes as well, where enemies could be killed by members transformed into bears (Hoffman, 1891). One of the most blatantly self-serving bits of ideology of many Plains secret societies was the assertion that supernatural power and prospects of success could be transferred to an initiate via an initiate’s wife having sexual intercourse first with a secret society leader, and then (presumably) afterward with the husband (Bowers, 1965).

Melanesia

Melanesian ideology was similar (Speiser, 1996). Many spirits were portrayed as malevolent and dangerous. However, high-ranking secret society members had the knowledge and rituals to control these dangerous spirits. This was accomplished primarily through the intermediary connections with powerful ancestral spirits (in a very broad sense). Pig sacrifices were claimed to be essential to feed the spirits and placate or supplicate them.

West Africa

In West Africa, ancestors were again the main intermediaries for exerting influence in the supernatural realms. Ancestors were invoked, or “channeled,” by donning ancestral masks in a fashion reminiscent of Northwest Coast secret society rituals.

The wearer thus became possessed by the ancestral spirit, and as such was “immune from all laws and regulations”; he was “above the law,” or “almost a law unto himself,” and not responsible for his own actions, sometimes even killing and eating his own son (Harley, 1950, p. vi, 5, 8; 1941a, pp. 132–133). Masks were portrayed as expensive to obtain and supernaturally activate, and only rich, high-ranking secret society members possessed them as well as a functional knowledge of the spirits. Members also had animal spirit helpers and could transform themselves into these animal forms, especially for killing people (Harley, 1950; Newland, 1916; Talbot, 1912). As elsewhere, the public rhetoric of these societies was that they provided important benefits for their communities in the form of defense, cures, prosperity, fertility, political and moral frameworks, economic regulation, and entertainment.

Acquiescence and compliance

As previously noted, some individuals undoubtedly believed at face value the public ideological rhetoric, stories, and claims that secret societies promulgated, while other people may have had reserved judgments. Secret societies developed a variety of strategies to convince the rest of the population of the validity of their ideological claims and their claims on the material or labor resources of the community. Typically, these included the hosting of public feasts to demonstrate that the societies benefitted communities and to display the wealth or power of secret societies. Giving food or gifts is a well-established means of obtaining acquiescence from people (Trenholm, 1989, Perloff, 2003). Public displays usually included demonstrations of claimed supernatural powers. These involved a wide range of physical and stage magic effects including fire handling, piercing of bodies with arrows or lances, plunging hands into boiling water, making objects move by themselves or transforming them, making plants grow instantaneously, decapitating individuals but then returning them to living states, other means of killing and reviving individuals, and shamanic duels. These effects were made as realistic and convincing as possible, with real death often meted out for botched performances. Such demonstrations seem to have been developed to convince spectators of the validity of the supernatural ideological claims of the secret societies. Similarly, the induction of ecstatic experiences in initiates (a characteristic feature of most secret societies) must have impressed both initiates and onlookers with the genuineness of secret society claims about their ability to contact the supernatural.

In addition to the aforementioned demonstrations, many secret societies put on regular manifestations of the power and destructiveness of *uncontrolled* supernatural spirits. These typically occurred during initiations when initiates became possessed by dangerous spirits. Before these spirits were brought under control by the rituals of the secret society, the possessed individuals marauded through the village, reeking destruction on households and terrorizing the entire community. Kinship connections and feasting debts or other debts must have also been employed to pressure individuals to comply with secret society wishes or dictates, including the acceptance of ideological claims.

Northwest Coast

In the Northwest Coast, those possessed by the cannibal spirit tore living dogs to pieces and ate them, or they bit pieces of flesh from spectators' bodies. Poor villagers lamented to Drucker that when secret societies held their rituals, they began to weep because they knew that someone would be murdered (Drucker, 1941). Thus, as in Melanesia and West Africa, the secret societies first created or manifested dangerous spirits (via fasting and other mind altering techniques), then released those possessed by dangerous spirits into the community to wreak havoc, and then "saved" the community by using their rituals to control those who were possessed by spirits.

For the most recalcitrant skeptics, secret societies resorted to brute force to obtain silence and acquiescence. Northwest Coast secret societies employed intimidation and coercion, especially using terror, but including threats to kill dissenters, physical attacks for disrespect or noncompliance to society rules, and ultimately murder and possibly cannibalism (Drucker, 1941). Intrusion into secret society affairs was met with death.

North America

In California, those who profaned secret society rituals were killed (Boscana, 1933), and bear impersonators could kill at whim (Loeb, 1932). In the Southwest, those who contravened the decisions of leaders of secret societies could be threatened, fined, ridiculed, thrown in rivers, whipped, expelled, or killed. On the Plains, intimidation, threats, and killing by supernatural means were coercive strategies (see Hayden, 2018).

Melanesia

With regard to the New Hebrides, Speiser (1996) reported that the entire island was terrorized before *Suque* members were promoted to higher ranks. It seems reasonable to assume that the vulnerable and especially the skeptics were special targets for all these acts of destruction and terror. If taboos and magic threats did not succeed, the uninitiated were beaten and their property plundered. Fines, destruction, and rape were common means of obtaining compliance. Anyone who "injured" a society member was threatened with death if not actually murdered and eaten.

West Africa

West Africa had some of the most severe penalties for transgressions of secret society rules, and the rules were numerous and varied. Guilty parties could be flogged, killed, and eaten. In the event of hamlets not complying with secret society wishes, armed bands of men dressed as spirits descended on, and destroyed, the households of offenders (Talbot, 1923). To ensure the fidelity of members to secret society interests, initiations involved moral transgressions such as cannibalism, with high ranks having to kill and eat their own sons (Harley, 1941b, 1950).

Both the moderate and drastic measures used to obtain compliance and acquiescence from *all* community members stand in stark contrast to the public rhetoric of secret societies (and elites in general) that their main goal was to help their communities and ensure the welfare of all members. I would like to suggest that the elaboration of ritual proscriptive and prescriptive rules was engineered primarily so that virtually everyone could be faulted at one point or another for transgressing the rules. Secret societies, or elites, could then decide whether to be lenient or severe in meting out punishments and fines depending on whether the offender was a supporter or foe, strong or vulnerable.

Assessment

What are we to make of these accounts of secret society leaders, and their behavior? The most readily apprehended features of leaders' motives, actions, and personalities are remarkably consistent with Hare's (1993) assessment of sociopathic individuals – the pursuit of their own interests to the extreme without regard for their impact on others whether competitors, kin, or innocent victims. Typically, their goals were to acquire power, wealth, and sex for themselves. Their self-images were usually defined by material possessions and signs of power or success. They had a need to control situations and people. They had no empathy for others beyond the need for supporters, yet they were often publicly charismatic and engaging as a means of manipulating others. They were masters at manipulation and liked to play head games with others as exemplified in their inductions of altered states in initiates and in their wild demonstrations of spirit terrors. And they considered themselves above the moral codes of their communities. They were aggressive and competitive, and constantly pushed for changes in social conventions that favored their strategies to achieve self-interested goals. At the psychopathic extreme, they indulged in murder – or worse – either at their whim, or specifically directed at those who opposed them. The promotion of ideologies favoring aggrandizer strategies together with the use of altruistic public rhetoric combined with threats, intimidations, debts, physical coercion, and murder seem completely consistent with sociopathic personality types. Thus, the personality characteristics of sociopaths (and in less extreme form: greedy, ambitious, power-hungry individuals) correspond closely to the personality characteristics of secret society leaders and members. Sociopaths are simply an extreme expression of this dimension of personalities.

Archaeologically, these personality characteristics might be identifiable from evidence for human sacrifices or cannibalism, slavery, major disparities in wealth (e.g., in burials or residences), prestige items or displays, power animal or intimidating iconographies, therianthropic power animal-human transformations, and ego-centered or megalomaniac monuments or inscriptions (e.g., Egyptian or Maya pyramids and early Chinese burial monuments).

Some of the stronger candidates for archaeological examples of secret societies come from Eurasia and include Jerf el Ahmar, Göbekli Tepe, and Lascaux Cave. Jerf el Ahmar is a small Pre-Pottery Neolithic A village site in Syria, dated to about

12,000 ybp (Stordeur, 2014). Several successive small semi-subterranean “community” buildings resembling Pueblo kivas were excavated near the center of the village, but the archaeologists dealing with the site have refrained from describing them as ritual in nature. Nevertheless, these structures contained displays of aurochs bucrania and iconographies of other power animals (raptors, snakes, foxes, and scorpions), and they had benches along walls similar to benches in some ethnographic examples of secret society structures. These benches had crude images of headless bodies engraved on vertical slabs. One of the structures also contained a headless human sacrifice left in the middle of the floor upon abandonment, as well as a number of heads under postholes and three cooked human heads in a hearth just outside the structure (Stordeur & Abbès, 2002). The small size of the structures indicates an exclusive or select number of people using the structure. The semi-subterranean construction indicates a desire to be hidden from public view, presumably to keep rituals secret. The unusual effort involved in building this structure together with the considerable space devoted to storage indicate unusual wealth and/or control over labor possessed by the builders. The wall benches indicate some sort of central focus in the middle of the structure as would be appropriate for addresses or ritual performances. The sacrificed human remains indicate a major concern with power. Thus, the community building at Jerf el Ahmar is one of the better candidates for a secret society structure.

Göbekli Tepe in southeast Turkey is a site that was contemporaneous with Jerf el Ahmar, but consisted only of structures that the excavators have identified as ritual in nature with no known residential sites in the vicinity (Dietrich & Notroff, 2015; Peters & Schmidt, 2004; see also Dietrich, Notroff, Walter & Dietrich, this volume). There are a number of semi-subterranean structures at this site with megalithic columns that are sculpted with a variety of bas-relief power animals (aurochs, boars, felids, raptors, foxes, snakes, scorpions). Similar iconographies are found within a 200 km radius of Göbekli, leading the excavators to propose that it was a regional ritual center. There is abundant evidence of feasting, including fragmentary human remains with cut marks all associated with animal food remains. The power and wealth implied by the sculpted megalithic columns, the remote location and semi-subterranean construction of the buildings, and the abundant food remains are typical of ethnographic secret society meeting places outside of villages as are the use of power animal images, and even the use of sculpted stone columns (similar to some West African secret society structures). Recent excavators have made comparisons with Melanesian ritual organizations as possible analogs to the ritual organizations and activities at Göbekli Tepe (Dietrich & Notroff, 2015). These Melanesian ritual organizations are usually considered as secret societies, e.g., the Duk-duk in the Bismark Islands. On the basis of the remote location, limited size of structures that were semi-subterranean to hide secret activities from view, the power animals depicted, possible anthropophagy, benches around the walls, and the display of labor control or wealth, I think there are strong arguments for considering Göbekli Tepe as a regional center for a secret society in the Pre-Pottery Neolithic A period.

I would also like to suggest that the more elaborately Upper Palaeolithic painted caves of Western Europe can be considered as likely ritual sanctuaries of secret societies as exemplified by Lascaux. Caves are obviously ideal locations for restricting access, for conducting rituals in secret, and for inducing altered or numinous states that typify secret society initiations. The highly sophisticated art and the preparations required to produce it are indicative of considerable specialization and control over wealth and labor. The art primarily features power animals (aurochs, bison, bears, felids, mammoths, horses) rather than subsistence animals, and the depiction of these animals was part of regional networks. Some of the associated art items depict therianthrope men or men with animal masks and tattoos such as depicted in Les Trois-Frères Cave (e.g., “The Sorcerer” [see Whitley, this volume]) and in carvings of lion-headed individuals in the Vogelherd and Hohlenstein-Stadel Caves. Many of the decorated locations in the caves could only accommodate a small, select number of people, and there can be little doubt about the ritual nature of the activities in the caves. Types of musical instruments typically used by secret societies were also found primarily in decorated caves (Morley, 2009, 2013). These caves sometimes contained special burials (e.g., Cussac) and exhibited evidence of cannibalism (Villa, 1992). Many of the caves including Lascaux may also have featured solar alignments, especially at the winter solstice, thus exhibiting the possession of esoteric knowledge typical of secret societies (Hayden & Villeneuve, 2011). Archaeologists dealing with Palaeolithic art have generally not considered the possible role of secret societies in the use and creation of these painted caves. Yet, viewing the painted caves as the product of secret societies explains by far the most outstanding features of these sites.

While the development of secret societies as a strategy to achieve the self-interests of aggrandizers could be shrugged off as incidental odd developments by small groups of outlier aberrant personalities with little consequence to the broader socio-cultural fabric, in fact, I think the creation of secret societies had far-reaching repercussions.

Ambitious individuals who found that their use of ancestral cults for self-aggrandizement was constrained by their kinship networks undoubtedly began to search for other ways to indebt, manipulate, exploit, and control larger segments of their communities and regions. Secret societies, founded on surplus and wealth payments, provided one of the most effective means of transcending those kinship networks. Far from being communitarian institutions that increased social solidarity (as most archaeologists argue was the function of early religious elaboration), secret societies *increased* socioeconomic inequalities and rivalries. They aggressively enforced acquiescence for their ideologies and material demands over *entire* communities, thereby transforming entire cultures. They also controlled the greatest amount of surpluses or wealth in the communities. They built elaborate ritual structures as well as using remote ritual sites including caves. They were heavily involved in the political control of communities – often including the most important kin group leaders – and they arguably created the basis for increased political centralization. They expanded their ritual connections to create regional networks. And finally, they established the first religious institutions beyond kinship-specific ancestor cults,

which I think ultimately led to early state and then world religious organizations. As elaborated in my monograph (Hayden, 2018), I think that secret societies provide a good explanation for why religion played such a major role in many of the major early centers of cultural complexity. Göbekli Tepe, Poverty Point, Chavin de Huantar, Chaco Great Houses, Stonehenge, and many other renowned early ritual sites are good possible candidates for evolved types of regional secret societies.

The traditional, often unstated, alternative is to assume that human nature was so strongly controlled by beliefs in the supernatural that people could be induced by charismatic ritualists to devote endless amounts of time, energy, and resources to build monuments to their gods and provide ritualists with ever more lavish accoutrements. I doubt that psychological studies would support such assumptions. Given the ethnographies on secret societies, I also doubt that these early centers can be understood without examining the more practical, ruthless, and self-interested motives and personality types that were involved in their creation. In the end, I would contend that if archaeologists want their discipline to be more than a sterile academic pursuit, it must include palaeopsychology, either implicitly or, preferably, explicitly.

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24

THE ARCHAEOLOGY OF MADNESS

David S. Whitley

Humans may be characterized by many traits: language, complex sociality, and technological advancements being just a few. Underpinning each of these is a sophisticated cognitive system. The relevance of cognition in the evolution of *Homo Sapiens sapiens* is acknowledged by archaeologists in the distinction between anatomically modern humans (AMH), skeletal remains effectively equivalent to our own that first appeared in Africa about 175,000 (or more) years before present (ybp), and cognitively modern humans (CMH), arguably not making their first appearance until the start of the Upper Palaeolithic period, roughly 50,000 ybp.¹ CMH have been recognized as such due to the appearance of complex toolkits and adaptive practices along with sophisticated art. Although there is debate about how quickly cognitive evolution followed skeletal changes, there is consensus that the two did not coevolve contemporaneously.

Cognition is itself a complex phenomenon that involves more than logic and computational and analytical skills. Implicated in reasoning, in addition, is emotion, inasmuch as emotions evolved alongside reasoning and play an active role in cognitive processes (e.g., Damasio, 1994; Hinton, 1999; Hobson, 1994; Gibbs, 2006; LeDoux, 1996; Midgley, 2003). As Izard observed, “Emotions play a critical role in the evolution of consciousness and the operation of all mental process” (2009, p. 1), while Damasio has described the feelings that result from emotions as the “bedrock of our minds” (2003, p. 3). The path to cognitive “modernity” also then involved the evolution of the emotional characteristics and conditions equivalent to what we find in human populations today (Whitley & Whitley, 2015). To fully identify the emergence of humans, as we understand ourselves as distinct from the animal world, then requires apprehending our emotional evolution. Yet how can an archaeologist chart the road to emotional modernity? The answer entails two problems: (1) identifying traits characteristic of emotional modernity that may have archaeological signals; and (2) tracing the appearance of those signals in the prehistoric record.

Mental illness represents an extreme expression of the full variability of the human emotional condition since “most mental disorders are emotional disorders” (LeDoux, 1996, p. 19), and at least some kinds of human mental illness are now recognized as a relatively recent development (Banerjee et al., 2018; Helvenston & Bednarik, 2011; Srinivasan et al., 2017). It follows that identifying emotional modernity would require finding archaeological evidence for mental illness. I argue specifically here that mood disorders (as one category of mental illness) can be traced back in time due to their association with specific members of small-scale hunter-gatherer societies, shamans, and one of the key cognitive-behavioral characteristics of these disorders and these individuals: unusual creativity (Whitley, 2009). The evidence suggests that shamanism initially appeared in the Western European Upper Palaeolithic period roughly 35,000 ybp, based on the first appearance of artistic masterpieces that display characteristics of altered states of consciousness (ASC) imagery. Recent genetic studies may help explain this circumstance: Introgressive hybridization of AMH with Neanderthal during the Upper Palaeolithic contributed a series of genes to the human population that are associated with major depression, bipolar disorder, autism, and schizophrenia. The emergence of CMH thus may be partly due to an inter-breeding between our direct ancestors and our earlier hominin relatives, leading not only to our emotional modernity but also to the creative genius that further defines us as human.

Shamans and mood disorders

Shamanism is a religious system predicated on direct personal interactions with the perceived supernatural world and its spirits, achieved through visionary experiences. (An anthropological catch-phrase emphasizing this definition is “priests talk to gods whereas gods talk to shamans.”) Shamanistic religions have been identified worldwide, typically (though not universally) among small-scale hunter-gatherer societies. Because visionary experiences result in a limited series of mental and somatosensory effects, a common repertoire of ritual practices, beliefs, and symbols characterizes most shamanistic religions. These include the use of hallucinogens or other methods to induce an altered state of consciousness, individual shamans as primary religious functionaries responsible for curing illness, and belief in “soul (or mystical) flight” as a component of a supernatural vision. This last trait is linked to the bodily metaphors that are widely used to describe the otherwise ineffable experiences of an altered state of consciousness (see the following text). Although it has been long hypothesized that shamanism was humankind’s first religion (Furst, 1977; LaBarre, 1980), its persistence and worldwide distribution can also be understood, even in the absence of a codified theology or historical connections, at least in part due to the continued reinforcement of its key symbols and beliefs (discussed later) resulting from the embodied nature of individual trance experiences.

The widespread association between shamanism and mental illness has been recognized for almost as long as Western travelers and scientists have interacted with shamanic societies (e.g., Ackerknecht, 1943; Devereux, 1961; Eliade, 1958; Lewis,

2003; Lommel, 1967). Indeed, an associated mental illness is so common among shamans that it has been generically referred to as the “shaman’s disease” by anthropologists. With reference to a female Siberian shaman, for example:

The most important *preliminary signs* of a *potential initiate* in a normal member of the community were, however, a nervous tendency appearing as a shaman’s sickness and a capacity for visions and auditions interpreted as supra-normal. . . . [The shaman Savonne was] in torment for a long time, and acted as one demented [until treated] . . . However, her marked nervous condition did not disappear in spite of the fact that Savonne began to practice shamanism. She did not want to be a shaman; she hoped to recover. But then she became reconciled with her fate and accepted the hereditary shamanistic calling of her mother (her mother was also a shaman).

(Siikala, 1978, pp. 189–190; *emphasis in original*)

Among the Mohave in California:

The Mohave themselves seem to sense that the shaman is really insane since, when a new sexual outrage perpetrated by a shaman becomes known, people tend to exclaim: “All shamans are crazy.”

(Devereux, 1969, p. 72)

Shamans cannot control themselves. They will do anything. Their [supernatural] power makes them act that way. It makes them crazy. . . . When they begin to cure, they quiet down. They become almost human.

(Devereux, 1969, p. 399)

And a personal account from the Arctic Inuit:

I would sometimes fall to weeping and felt unhappy without knowing why. Then for no reason all would suddenly be changed, and I felt a great, inexplicable joy, a joy so powerful that I could not restrain it, but had to break into song.

(Rasmussen, 1929, p. 119)

As these accounts indicate, the shamanic vocation was invariably preceded by sickness, the only cure for which was thought to be becoming a practicing shaman. As Devereux then contended with respect to shamans:

Unless we assume that psychotic eruptions can arise *ex nihilo*, without unconscious antecedents, or that spirit possession (in the occultist sense) is a reality obliging the anthropologist to believe in the existence of spirits, we must assume that a person who briefly lapses into a psychosis has an

active, though latent and unconscious, psychotic core. Clinical evidence on this score is overwhelming.

(Devereux, 1961, p. 1089)

Notably, this sickness and thus the shamanic vocation were widely associated with suicide, itself highly correlated with mood disorders: Two-thirds of all suicides are estimated to have resulted from a mood disorder, and individuals with these illnesses are almost 80 times more likely to commit suicide than those with no psychopathology (Jamison, 1993, p. 41). The Mohave, believing that shamans received their calling in the womb, so strongly linked suicide and shamanism, for example, that they attributed natal mortality as a sign that the deceased infant had become a shaman before birth (Devereux, 1969).

A global synthesis of various reports on shamans' mental and emotional states then includes the following symptoms and behavioral tendencies:

- [Shamans] suffered from a hereditary illness;
- The onset of this disease varied from adolescence to middle age, but it first appeared most commonly during young adulthood (late teens and early twenties);
- It was transitory but recurrent, involving periods characterized by greatly diminished social function and ability, matched against other times of normal functioning;
- The initial manifestation was lengthy, often lasting a year or more;
- Visual and auditory hallucinations were common, especially during this initial episode;
- Physical pain and torment also sometimes accompanied the first manifestation;
- Passivity and social withdrawal could occur or, alternatively, extreme agitation and mania;
- Melancholic moods and intensely elated states sometimes alternated and were independent of immediate circumstances;
- Highly anti-social and obnoxious behavior was also common, during the initial outbreak especially, but also later in life;
- Sexual promiscuity, including outrageous sexual misconduct, and other kinds of impulsive behavior were typical;
- Unusual sleep patterns, including in particular middle insomnia, may have been characteristic of their illness; and
- Suicide was associated with those that suffered from this disease.

(Whitley, 2009, pp. 226–227)

There has been historical debate about the proper diagnosis of the shaman's disease (e.g., Devereux, 1961, 1969; Noll, 1983; Silverman, 1967), aspects of which have been confused by differing terminology, the temporally variable diagnostic criteria of Western psychiatry, and our larger understanding of mental illness (Whitley, 2009, pp. 212–213). A most likely and conservative general diagnosis, nonetheless, has

been suggested based on criteria in the *Diagnostic and Statistical Manual of Mental Disorders IV* (Whitley, 2009). This is that shamans widely suffered from mood disorders, now understood (based on genetic evidence) to include a continuum ranging from bipolar, major depressive, schizoaffective, and autistic spectrum disorders to schizophrenia.² Mood disorders, importantly, result from both genetic and environmental causes (e.g., Crow, 2007; Flint & Kendler, 2014; Kohli et al., 2011; Lichtenstein et al., 2009; Ohtsuki et al., 2002; Sato & Kawata, 2018; Sherman, 2012; Wray et al., 2018), but genetic inheritance constitutes up to 70% of the risk factor for these diseases (Gao et al., 2012).

Creativity and mood disorders

That ethnographic shamans suffered from mental illness, most likely some form of mood disorder, is repeatedly and convincingly demonstrated in the primary anthropological literature. To infer that prehistoric shamans may have also suffered from these disorders requires behavioral evidence that is both characteristic of those with these maladies and is archaeologically visible. Unusual creativity, expressed in art, is one possibility in this respect, for the association between mental illness and unusual creativity has been recognized since antiquity. According to Plato's *Phaedrus*, dating from approximately 370 BC, for example, Socrates stated that:

[There is a] kind of madness that is possession by the Muses, which takes a tender virgin soul and awakens it to a Bacchic frenzy of songs and poetry that glorifies the achievements of the past and teaches them to future generations. If anyone comes to the gates of poetry and expects to become an adequate poet by acquiring expert knowledge of the subject without the Muses' madness, he will fail, and his self-controlled verses will be eclipsed by the poetry of men who have been driven out of their minds . . . There you have some of the fine achievements – and I could tell you even more – that are due to god-sent madness.

(Plato, Phaedrus 245b)

Although this was initially just an anecdotal even if long-lived folk-belief, numerous recent clinical studies have repeatedly verified Socrates' claim, demonstrating the empirical association between mental illness and unusual creativity/artistry (e.g., Akinola & Mendes, 2008; Akiskal & Akiskal, 1988, 2005, 2007; Andreasen, 1987, 2008; Andreasen & Canter, 1974; Baas, De Dreu, & Nijstad, 2008; Davis, 2009; Goodwin & Jamison, 2007; Jamison, 1989, 1993, 2011; Kyaga, Lichtenstein, Boman, Hultman, & Långström, 2011; Ludwig, 1992, 1994; Murray & Johnson, 2010; Previc, 2009; Richards, Kinney, Lunde, & Benet, 1998; Santosa et al., 2007; Simeonova, Chang, Strong, & Ketter, 2005; Tremblay, Grosskopf, & Yang, 2010; Weissman-Arcache & Tordjman, 2012). Scientific confidence in this association is especially strong: In addition to replication, these studies have used different kinds of data, a variety of data sets, and varying analytical methodologies, all reaching the

same conclusion. They even include one example that examined the medical and professional records of almost 1.2 million individuals (Kyaga et al., 2012). Note that they have also demonstrated that mental illness is not required to have unusual creativity, and that degree of creativity is not positively correlated with severity of mental illness. Indeed, those with sub-clinical cases are often the most productive artists. Overall, however, the correlation between mental illness and unusual creativity is now a well-established fact.

It is then reasonable to hypothesize that, given the association between shamans and mental illness, shamans likewise should exhibit unusual creativity in one form or another (cf. Furst, 1977). One ethnographic trait of shamans is worth emphasizing because of its archaeological implications: Shamans are widely (though not universally) known to have created rock art – rock and cave paintings (pictographs) and engravings (petroglyphs; Whitley, 2011). Figure 24.1



Figure 24.1 A petroglyph from the Coso Range, California, showing a shaman wearing a quail topknot feather headdress and a ritual tunic.

Figure 24.1 is to be made available as a downloadable e-resource at www.routledge.com/9781138594500.

Source: Photo by David S. Whitley.

shows a petroglyph from the Coso Range, California. Based on ethnographic evidence, we know that Shoshone shamans in this region created rock art to portray the ASC imagery of their vision quests, during which they obtained supernatural power and power objects from spirit helpers (Whitley, 2000). This example is an engraving of a rain shaman wearing an elaborately painted ritual shirt and a quail topknot feathered headdress, characteristic ceremonial attire of this shamanic specialty.

Rock art and ASC imagery

As noted in the preceding text, shamans widely though not universally made rock art. Rock art alone is not then diagnostic of shamanism. There are nonetheless clues to the shamanic origin of a corpus of rock art based on the fact that, when creating rock art, shamans characteristically portrayed the visionary imagery of their ASC experiences, and the mental imagery of ASC itself follows regular patterns (even though individual interpretations of this imagery may vary). Using clinical and ethnographic data, Lewis-Williams and Dowson (1988) developed a model of this mental imagery. Their model includes three progressive stages of trance, seven kinds of geometric light images (“entoptic phenomena”), and seven types of perception, all of which are typical of many ASC (Figure 24.2). In the initial stage an individual commonly perceives just entoptic images alone (e.g., zigzags, grids, concentric circles, etc.). Next, these geometric patterns are construed as identifiable iconic or representational forms (e.g., a zigzag pattern as a snake). Finally, the individual may sense that they are fully participating in their trance, e.g., becoming the snake. Throughout these stages the images may be perceived in a variety of fashions including inverted, superimposed upon one another, replicated multiple times, broken into component parts, and so on.

Lewis-Williams and Dowson tested their model on a corpus of rock art ethnographically known to have been created by shamans to depict their ASC experiences. The inferential efficacy of the model has subsequently been demonstrated a number of times with respect to other ethnographically known examples of shamanic art. Lewis-Williams and Dowson’s model thus provides a neuropsychological bridge allowing us to infer whether a specific prehistoric corpus of rock art originated in trance imagery and therefore likely from a shamanic experience.

ASC do not solely result in mental images, however. Noted earlier is the fact that ASC are ineffable experiences, and they are commonly described using metaphors that themselves are based on the somatosensory effects of trance (Lewis-Williams & Loubser, 1986; Whitley, 1994, 2000). “Soul flight,” referred to in contemporary terms as an “out-of-body experience” or, during the 1960s, as “going on a trip,” is one such ASC metaphor. “Going on a trip” in fact is a verbal metaphor for this particular ASC reaction that has been used, entirely independently, by Westerners during the 1960s, and ethnographically by the Jivaro in lowland South America, speaking to the cross-cultural nature of these bodily and emotional effects. Other common trance metaphors include bodily transformation (especially confections of

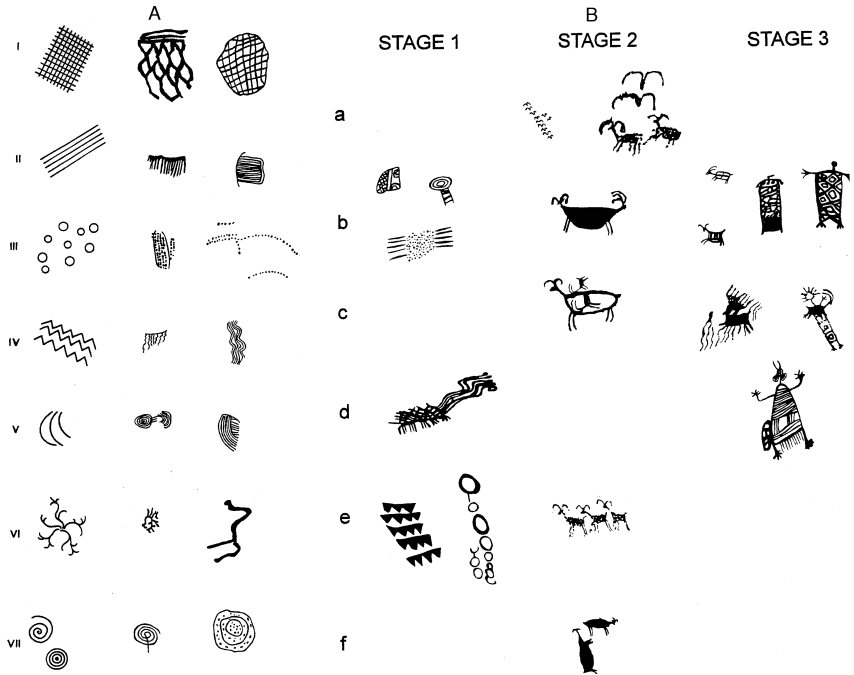


Figure 24.2 Lewis-Williams and Dowson's (1988) neuropsychological model for ASC imagery. This model outlines the origins, though not the specific cultural meanings, of motifs created to portray visionary experiences. A – the seven most common entoptic light patterns, with idealized versions on the left and examples from the Coso Range petroglyphs on the right. B – the three characteristic stages of trance (columns) and the seven principles of perception (rows) in ASC imagery, again using examples from the Coso Range petroglyphs. The principles, from top to bottom of the rows, are simple replication (A); fragmentation; integration; superposition; juxtaposition; reduplication; and rotation.

Figure 24.2 is to be made available as a downloadable e-resource at www.routledge.com/9781138594500.

human and animal features), grief/death/killing, combat/aggression, drowning, and sexual arousal (Whitley, 1994, 2000).

There is an important point, however, with respect to fully apprehending these metaphors. This concerns the nature of ASC. Contemporary Western perceptions of shamanic ASC have incorrectly conflated them with an ecstatic transcendental state. Ethnographic descriptions of shamanic visionary experiences demonstrate instead that it could be quite different, and was often frightening and violent – equivalent, in Western terms, to a “bad trip” (Whitley, 2009). Thus it is the feeling of grief or even death that was characteristic of the shaman's state of consciousness, and that served as the embodied source for certain shamanic metaphors. Lewis-Williams and Dowson's (1988) neuropsychological model can then be combined with these metaphors of trance, as characteristic symbolic motifs or themes of shamanic arts, to

evaluate whether a corpus of art resulted from an altered state of consciousness and thus likely from shamanism.

Returning to Figure 24.1, for example, note that the human figure has an entoptic form, concentric circles, as a face, while the ritual shirt pattern is itself a complex entoptic pattern. Rather than human feet, the figure has bird claws, signaling that the shaman is partly transformed into a human-avian being and has experienced mystical flight. This ASC metaphor is further encoded in the culturally specific meaning attributed to the entoptic/concentric circle face: Among the Shoshone, concentrics and spirals symbolized the whirlwind, which was believed to carry shamans into the supernatural. Even more importantly, the attributes of the neuropsychological model and the metaphors of trance are pervasive components of the corpus of Coso petroglyphs as a whole, far beyond this individual motif alone (Whitley, 2000).

The antiquity of shamanism and art

Archaeological evidence for the antiquity of shamanism – and potentially by inference mental illness – is primarily found in iconography that includes the characteristic mental imagery of trance and the shamanic metaphors of ASC. Evidence supportive of the intentional acquisition of ASC, usually in the form of hallucinogens, may also contribute. Early art has now been found in a number of locations globally. Early evidence specifically for shamanic rock art, identified using the Lewis-Williams and Dowson (1988) neuropsychological model combined with the shamanic metaphors for trance, has been found on a number of continents. In North America, shamanism is believed to be 12,000 years or more in age. This is based on continuity in the use of a corpus of rock art that illustrates the neuropsychological model; continuity in a key iconographic motif (the bighorn sheep) as well as specific details of the portrayal of that motif; continuity in the use of the same sites for this duration; and continuity in the use of a specific ritual tool, quartz hammerstones, to engrave the petroglyphs (Whitley, Dorn, Simon, Whitley, & Rechtman, 1999; Whitley, 2013). In southern Africa shamanism dates as early as 30,000 ybp, based on pictographs portraying human-animal conflation on plaquettes excavated from stratigraphic levels in Apollo 11 Rockshelter, Namibia (Lewis-Williams, 1983; Vogelsang et al., 2010). In Western Europe, shamanism is 37,000 or more years old, based on analyses of the corpus of art at Chauvet Cave, France, and other sites such as Lascaux and Pech-Merle, France, and Altamira, Spain (Clottes, 2003; Clottes & Lewis-Williams, 1998; Quilesa et al., 2016).

Figure 24.3 shows a painted panel from Chauvet Cave, France, dating between 33,500 and 37,000 ybp. It shows an upright human partly transformed into a bison, adjacent to a human vulva. This combines the shamanic metaphors of bodily transformation and sex, painted in a “dark zone” cave: an environment that, due to sensory deprivation, naturally results in ASC without need for hallucinogens. The Western European Upper Palaeolithic corpus as a whole contains numerous examples of other shamanic metaphors, along with the depictions displaying the principles of ASC perception and entoptic forms (Clottes & Lewis-Williams, 1998).



Figure 24.3 The so-called Sorcerer's Panel from Chauvet Cave, France, with a human-bison conflation and vulva.

Figure 24.3 is to be made available as a downloadable e-resource at www.routledge.com/9781138594500.

Source: Photo by and courtesy of Jean Clottes.

When combined with shamanic metaphors depicted in small figurines of similar age found in excavated contexts (e.g., Conard, 2003), the European Upper Palaeolithic period provides the earliest evidence for the appearance of shamanism worldwide, dating between roughly 35,000 and 40,000 ybp.

Western European shamanic rock art does not, however, represent the earliest example of cave paintings (e.g., see Aubert et al., 2014), even in Western Europe (e.g., Slimak, Fietzke, Geneste, & Ontañón, 2018). The earliest cave paintings from Western Europe and Southeast Asia demonstrate that the cognitive capacity and social need to create cave art (including, in Asia, easily recognizable iconic images) had been established in human populations as early as 50,000 ybp (Taçon et al., 2014). The Western European shamanic cave art instead stands out because of its unusual degree of artistry. Indeed, this corpus of cave paintings and engravings is widely recognized as including masterpieces of artistic genius (e.g., Pfeiffer, 1982).

Our first evidence for shamanism then occurs not simply with the first appearance of art, but roughly ten millennia later, with the first appearance of true masterpieces of art. These are masterpieces in that they are technically sophisticated works of artistic craftsmanship. They include compositions expressing complex (shamanic) metaphors; and (I believe) they would be recognized as aesthetic masterpieces cross-culturally (Whitley & Whitley, 2015). They are, in a sense, timeless. Materialist explanations for the proliferation of this corpus of art in Western Europe at this time focus on their communicative significance and roles, and the social and environmental contexts within which they were produced. While these functions and contexts certainly were important, they fail to explain the empirical (even if qualitative) fact that the art reflects an expression of unusual levels of human artistry. Mediocre or even poor art can fulfill the same communicative and symbolic purposes, and can result from the same contexts (such as competition over resources or, alternatively, excess productive capacity). But creative genius itself is a true empirical phenomenon, and it requires explanation beyond the generic fact that humans make art to communicate symbolically.

Although my argument is inferential (and, admittedly, speculative to a degree), it follows that because ethnographic shamans suffered from mental illness and were partly therefore unusually creative, the correlation between the first appearance of shamanism (independently identified based on portrayals of ASC mental imagery and shamanic metaphors) and the first evidence for artistic masterpieces potentially reflects evidence for the appearance of mood disorders in the human population. We can date the appearance of mood disorders, in other words, based on the first evidence for artistic-shamanic genius. The question this then raises is: Why would mental illness associated with unusual creativity first appear in Western Europe circa 35,000–40,000 ybp?

Introgressive hybridization and mood disorders

Based on the identification of the complete Neanderthal genome, the hybridization between these early hominins and AMH has been established (Green et al., 2010b), with Neanderthal admixture now estimated to contribute between 1.5 and 2.1% of the genome variation in contemporary European and Asian populations. A second hominin, the Denisovans, contributed a smaller amount (>1%) of the DNA of non-Africans, with the exception of Papuans and other Oceanic/Melanesian peoples, who have between 2 and 6% Denisovan mutations (Llamas et al., 2017). With respect to the Neanderthal contribution, Harris and Nielsen (2016) calculate that the admixture evident today requires an initial contribution as high as 10%. Inter-breeding between AMH and these earlier hominins, in other words, was not a one-off occurrence but instead resulted from repeated introgressive backcrossing gene flows between populations.

One outcome of this genetic research has been the realization that certain contemporary ailments are associated with genes inherited through this introgressive hybridization with Neanderthals and Denisovans. This includes genes implicated in

mood disorders (Calaway, 2015; Ferreira, Rodrigues, Broach, & Briones, 2017; Gibbons, 2016; Llamas et al., 2017; Reardon, 2017; Simonti et al., 2016; Uricchio, Kitano, Gusev, & Zaitlen, 2017), specifically major depression and schizophrenia, as well as immune responses, and cranial and brain shape, thereby affecting neurological function and disorders (Gregory et al., 2017). As Simonti et al. observed:

The significant replicated association of Neanderthal SNPs [single nucleotide polymorphisms] with mood disorders, in particular depression, is intriguing since Neanderthal alleles are enriched near genes associated with long-term depression, and human–Neanderthal DNA and methylation differences have been hypothesized to influence neurological and psychiatric phenotypes. Depression risk in modern human populations is influenced by sunlight exposure, which differs between high and low latitudes, and we found enrichment of circadian clock genes near the Neanderthal alleles that contribute most to this association.

(2016, p. 737)

Circadian rhythms, notably, are themselves associated with bipolar disorder and depression (e.g., Nievergelt et al., 2006). Sherman (2012) has further suggested that bipolar disorder is itself an adaptation to the severe Pleistocene climate of Western Europe during the Upper Palaeolithic period, arguing that bipolar disorder results in the human equivalent of hibernation, which could help optimize resource allocations between the active/manic summer versus inactive/depressive winter seasons.

It is important here to emphasize that these mood disorders are both polygenic (i.e., associated with multiple gene mutations) and influenced by environmental factors. Having one or even a few genes alone does not result in these mental illnesses. But the important point is that, during the period of introgressive hybridization, the AMH population acquired genes that enhanced the likelihood of acquiring a mood disorder at a time during which climatic conditions naturally would have affected their circadian rhythms, creating an external context that could increase the prevalence of these illnesses. The part that introgressive hybridization may have played in the appearance of mood disorders in the AMH population is then a question of relative degree, enhancing the likelihood that a significant proportion of this group developed these ailments, rather than a simple presence–absence switch.

Discussion

Our inherited Neanderthal genes associated with mental (and other) illnesses may or may not have been an adaptive component of the Neanderthal genome, but they have had very different impacts on AMH. With respect to the potential effects of these genes on creativity, archaeological evidence provides little support for any unusual degree of Neanderthal innovation, inventiveness, or artistry: With the exception of minor additions to their material culture such as personal ornaments and possibly painted cave wall markings during the period of their overlap with

AMH (the so-called Châtelperronian transitional period, after about 50,000 ybp), Neanderthal culture was essentially unchanging for hundreds of thousands of years (cf. Rossano, 2015). Although there is archaeological evidence that AMH populations over time slowly added additional behavioral tendencies prior to the Upper Palaeolithic and outside of Europe, potentially signaling gradual cognitive advances, the divide between the Western European Upper Palaeolithic archaeological record and what came previously, or occurred in other regions at that same time, is still dramatic (cf. Culley, 2016). As Conard noted:

[F]igurative art, complex religious beliefs documented in the material record in the form of therianthrope images, large numbers of personal ornaments shaped in three dimensions, and musical instruments appear in the [European] archaeological record. These innovations reflect the appearance of fully developed, symbolically mediated lifeways among anatomically modern humans. These new behavioural adaptations in connection with highly affective lithic and organic technologies must have provided modern humans with more reliable access to caloric and nutritional resources, which in most regions of the zone of contact gave them a demographic advantage over the indigenous populations of archaic peoples.

(2008, p. 177)

Assuming my inferential reconstruction linking shamanism, mental illness, unusual creativity, and introgressive hybridization is correct, there are then two final issues that warrant discussion. The first concerns the first appearance of CMH, which I argue was geographically isolated in Western Europe, and the potential implication of this circumstance for the global distribution of unusual creative capabilities. Different global populations have varying proportions suffering from mood disorders (e.g., Kessler & Ustun, 2011; Weissman et al., 1996), though it is not entirely clear whether (or how much) this relates to diagnostic differences and/or cultural attitudes and values (Chiao & Blizinsky, 2010; Gonda, Vasquez, Akiskal, & Akiskal, 2011). Similarly, certain historical factors (such as expendable wealth) contribute greatly (even if indirectly) to artistic expression. But there is no credible evidence to suggest that innate human creative talent is somehow now restricted to any region, population, or culture. Given my argument that unusual creativity in part resulted from hybridization in Western Europe, the global spread of creativity would then require explanation, especially for African populations that are often viewed as lacking any Neanderthal or Denisovan inheritance.

But as recent research has demonstrated, early AMH are only “modern” in a skeletal sense for, as Cochran and Harpending (2009, p. 52) have observed: “The majority of adaptive genetic events do not have noticeable skeletal signs.” The human genome has evolved and continues to evolve rapidly; in no sense is it fixed. Instead it is globally subject to rapid changes through at least two processes: “back-flows” and “selective sweeps” (e.g., Schlebusch, Sjödin, Skoglund, & Jakobsson, 2012; Voight, Kudaravalli, Wen, & Pritchard, 2006; Wang et al., 2004;). One – visible – example

of this fact is the distribution of the SLC24A5 skin pigmentation allele. This results in light skin coloring. It only appeared about 5,800 years ago, yet it is now almost universal in European populations, and it occurs in significant proportions in Africa and Southwest Asia (Cochran & Harpending, 2009).

With respect to Africa specifically, a “Back-to-Africa” hypothesis was proposed by Henn et al. (2012). This contended that Eurasian populations returned to Africa, genetically affecting a wide-range of sub-Saharan populations. Subsequent research has supported this hypothesis. Gurdansani et al., for example, found:

[S]ubstantial Eurasian ancestry in many African populations (ranging from 0% to 50%), with the greatest proportion in East Africa . . . ancient Eurasian admixture was observed in central West African populations (Yoruba; 7,500–10,500 years ago), old admixture among Ethiopian populations (2,400–3,200 years ago) consistent with previous reports, and more recent complex admixture in some East African populations (150–1,500 years ago) . . . Our finding of ancient Eurasian admixture corroborates findings of non-zero Neanderthal ancestry in Yoruba, which is likely to have been introduced through Eurasian admixture and back migration, possibly facilitated by greening of the Sahara desert during this period.

(2015, p. 329)

Perhaps even more importantly, according to Ferreira et al.:

Our data shows [sic] that Neandertal signatures are present in all major African haplogroups thus confirming that the Back to Africa contribution to the modern mitochondrial African pool was extensive.

(2017, p. 190)

That unusual creativity may have resulted from an increased prevalence of mood disorders in Western Europe due to hybridization between AMH and Neanderthals during the Upper Palaeolithic period thus has no current implications for the contemporary distribution of artistic and other talents. It instead may help explain why CMH appear archaeologically at different times in distinct regions, and are now found worldwide, as a result of not an evolutionary tree so much as an evolutionary bricolage.

The second issue concerns contemporary Western perceptions of mental illness, which generally hold that “mad is bad.” My argument instead is that the occurrence of mental illness is part of what defines us as CMH, and this aspect of our emotional condition has contributed significantly to the variability and richness of our lives. Madness is part of what makes us cognitively modern. Inasmuch as we value unusual creativity, humankind may then be better served by recognizing, celebrating, and promoting this fact, rather than stigmatizing the mentally ill.

Notes

- 1 There is significant debate concerning whether the appearance of CMH was a gradual/progressive, punctuated/discontinuous, or saltational/sudden event (see D’Errico & Stringer, 2011). Following arguments by Conard (2008), Culley (2016), and Whitley (2009; Whitley & Whitley, 2015), I support the hypothesis that there was a true Upper Palaeolithic revolution in the sense of an archaeologically sudden transition that first occurred in Western Europe.
- 2 Previously I argued that shamans were not likely schizophrenic due to the progressively debilitating nature of this disease, which would have precluded them from fulfilling important social functions (Whitley, 2009). This also reflected the then-common belief that schizophrenia was etiologically distinct from the other mood disorders. Ongoing genetic studies have demonstrated instead that schizophrenia along with bipolar, major depressive, and autism spectrum disorders have certain of the same gene associations and therefore etiologies, and thus are not necessarily fully distinguishable maladies (e.g., Carroll & Owen, 2009; Cross-Disorder Group of the Psychiatric Genomics Consortium, 2013; Green et al., 2010a; International Schizophrenia Consortium, 2009; Lichtenstein et al., 2009; Moskvina et al., 2009; Ohtsuki et al., 2002; Peerbooms et al., 2011; Sullivan et al., 2012; cf. Craddock & Owen, 2005).

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THE PREHISTORY OF PSYCHOACTIVE DRUG USE

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Most adults regularly use at least one psychoactive drug. Globally popular options include caffeine (found in coffee, tea, soft drinks, and chocolate), alcohol, nicotine, arecoline and other psychoactive compounds in areca nuts (i.e., betel nuts, used by 10–20% of the global population), THC and other cannabinoids, opioids, amphetamine and its chemical analogs found in khat and other plants, and cocaine (Gupta & Warnakulasuriya, 2002; Peacock et al., 2018; Verster & Koenig, 2018). Few realize, however, the extraordinary time depth in which people have been interacting with these plants.

The most influential scientific account of human psychoactive substance use focuses on the *mesolimbic dopamine system* (MDS), a collection of dopamine neurons in the midbrain of humans and many other animals that plays a central role in Pavlovian conditioning and similar types of reinforcement learning. According to this view, the MDS evolved to reinforce behaviors that increased access to so-called *natural rewards*, such as food, sex, and other necessities of survival and reproduction (Glimcher, 2011; Wise, 1996).

Surprisingly, many popular psychoactive drugs also stimulate the MDS. This fact provides for a compelling theory of drug use: Drugs happen to activate behavior-reinforcement circuitry in the brain, thereby reinforcing drug consumption (cf. Nutt, Lingford-Hughes, Erritzoe, & Stokes, 2015; Everitt & Robbins, 2016; Koob & Volkow, 2010; Wise, 1996). But it also raises an important question: Why would drugs, which are often harmful to the user, activate brain circuitry that evolved to reinforce biologically beneficial behaviors like obtaining food and sex?

The hijack hypothesis

Neurons communicate using a variety of neurotransmitters such as dopamine, serotonin, and acetylcholine. Neural functions are therefore vulnerable to disruption by environmental compounds that resemble these signaling molecules. According to

the *hijack hypothesis*, the MDS evolved long before inventions such as pipes, cigarette papers, hypodermic syringes, and the ability to synthesize or purify drugs made drug addiction possible (Wise, 1996). The MDS is therefore vulnerable to hijacking by chemicals that are evolutionarily novel, especially in their purity or concentration, are consumed in a novel fashion, and provide no evolutionary fitness benefits (e.g., Kelly & Berridge, 2002; Hyman, 2005; Volkow, Baler, & Goldstein, 2011).

Although the hijack hypothesis is widely accepted, it has never been empirically tested, and there are many reasons to doubt it. A range of evidence from human physiology, animal behavior, plant biology, and archaeology indicates that the human lineage has been exposed to potent psychoactive substances for hundreds of millions of years, that we are well-adapted to these substances, and that they might provide pharmacological and other benefits (Hagen et al., 2009, 2013; Hagen & Sullivan, 2018; Sullivan, Hagen, & Hammerstein, 2008; Sullivan & Hagen, 2002).

The evolution of psychoactive drugs in an ancient evolutionary arms race

Organisms harvest free energy from the environment to promote their own survival and reproduction. The earliest organisms, which appeared sometime between 3.5 and 4 billion years ago, probably harvested chemical energy, perhaps near geothermal vents (Weiss et al., 2016), and shortly thereafter some evolved to obtain energy from sunlight (Judson, 2017). Organisms that harvest energy from such inorganic sources are termed *autotrophs*.

Organisms that harvest energy from organic sources, such as eating other organisms, are termed *heterotrophs*. Although there is still debate, the first heterotrophs appear to have evolved from autotrophs to, ironically, feed on autotrophs (Schönheit, Buckel, & Martin, 2016). Early on, heterotrophs probably fed on dead autotrophs because energy availability and hence growth rates were too low to support predation (Judson, 2017). But after the evolution of oxygenic photosynthesis in cyanobacteria, circa 2.4 billion years ago, the concentration of oxygen in the atmosphere began to increase dramatically, which increased the free energy available for newly evolving organisms to exploit (Hohmann-Marriott & Blankenship, 2011). The first eukaryotes appear during this epoch.

The increased availability of energy enabled the evolution of heterotrophs that could survive and reproduce by eating *living* autotrophs, as well as other heterotrophs. This set the stage for a critical evolutionary dynamic: an evolutionary arms race in which autotroph and heterotroph prey evolved defenses against heterotroph predators, which evolved to evade or neutralize those defenses, selecting for better prey defenses, and so forth (Dawkins & Krebs, 1979). Armor, for example, first appears in the fossil record circa 700–800 million years ago (Porter, 2011). Arms races between predators and prey were key evolutionary forces driving the diversification, first, of single-celled eukaryotes, some of which could consume other cells (phagocytosis), and later, multicellular organisms, including the first animals (for brief review, see Judson, 2017).

Toxins are a key prey defense against predators. Extant cyanobacterial and other phytoplankton species at the base of the marine food web are notorious for producing a wide range of deadly toxins (Wiegand & Pflugmacher, 2005). Toxins continued to play a critical defensive role when the arms race between autotrophs and heterotrophs expanded to terrestrial environments circa 400 million years ago with the evolution of terrestrial plants and animals. Tens of thousands of plant toxins have been identified, many of which specifically target animal nervous systems (Wink, 2015). Microbes, fungi, and many animals also produce or sequester toxins, including neurotoxins, for defense and other functions.

With the exception of alcohol, all globally popular recreational drugs, including caffeine, nicotine, THC, arecoline, opioids, amphetamines, and cocaine, are plant defensive neurotoxins or their close chemical analogs (Sullivan, Hagen, & Hammerstein, 2008; Sullivan & Hagen, 2002). Nicotine, one of the most addictive drugs, is an especially dangerous plant neurotoxin. Smokers absorb about 1 mg of nicotine per cigarette, and chewers about 4 mg per wad (Hukkanen, Jacob, & Benowitz, 2005). Slightly higher doses of 4–8 mg cause burning of the mouth and throat, nausea, vomiting, and diarrhea. Even higher doses result in dizziness, weakness, and confusion, progressing to convulsions, hypertension, and coma. Ingestion of concentrated nicotine pesticides can cause death within five minutes (Landoni, 1991).

Toxin defenses

Human physiology was profoundly shaped by our co-evolution with toxic plants. The human lineage, which extends from our recent plant-eating primate ancestors to our more distant marine vertebrate and early eukaryotic heterotrophic ancestors that might have fed on potentially toxic cyanobacteria and other phytoplanktons, has been exposed to toxic compounds for at least half a billion and perhaps one billion years or more. As a consequence, we have evolved an extremely sophisticated, multi-layered toxin defense system.

Animals evaluate food, in part, via its taste. Vertebrates, including fish, have repertoires of bitter taste receptor proteins, coded by the T2R gene family, that detect a wide range of toxic substances (Meyerhof et al., 2010). Carnivorous species have the fewest T2R genes, whereas herbivorous species have the most, suggesting that exposure to plant toxins was a major selective force shaping the evolution of these genes (Li & Zhang, 2013). Humans have about 25 T2R genes, similar to other primates (Dong, Jones, & Zhang, 2009). All common plant drugs taste bitter, indicating that human physiology correctly identifies them as toxic.

If, despite its bitter taste, a plant neurotoxin is ingested, it must pass through multiple toxin defense systems before reaching the brain. Our bodies can be conceived as a set of compartments, such as the intestines and lungs, that are separated by tissue barriers made up of epithelial or endothelial cells linked together with special proteins forming “tight junctions.” These tissue barriers include our skin, gastrointestinal tract, respiratory tract, and the blood brain barrier (BBB). The

barriers have several functions, such as allowing an influx of essential chemicals like sugar and oxygen into a compartment, and simultaneously preventing an influx of microorganisms and toxins (Mullin, Agostino, Rendon-Huerta, & Thornton, 2005). The barriers achieve these effects by limiting or enhancing passive diffusion across the cells and tight junctions, and also by active mechanisms that transport essential chemicals into a compartment and that neutralize and transport toxins and other xenobiotics out of a compartment using networks of xenobiotic-sensing receptors, xenobiotic metabolizing enzymes, and xenobiotic transporter proteins. Many toxins are metabolized and excreted by the gastrointestinal barrier, or trigger nausea and are expelled by vomiting, while at the same time triggering aversive learning mechanisms in the CNS that will help prevent future consumption.

Toxins that evade these barriers and pass into the bloodstream are immediately routed to the liver, an organ that is specialized for metabolizing toxins and other compounds. Should some quantities of plant neurotoxins remain, they then face the BBB, which prevents most toxins from entering the brain (Pardridge, 2012). The existence of the BBB is further evidence that neurotoxic compounds were a strong selection pressure on the human lineage (for a brief review of barrier and other toxin defenses, see Hagen & Sullivan, 2018, and references therein).

In summary, popular recreational drugs are neurotoxic plant pesticides, a diverse class of compounds that has infused the diets of human ancestors for hundreds of millions of years. These and other xenobiotics selected for a robust, multilayered toxin defense system that correctly identifies all drugs of abuse as toxins via bitter taste receptor and other xenobiotic-sensing proteins, and successfully metabolizes and excretes them. It is therefore doubtful that recreational plant drugs are best characterized as evolutionarily novel hijackers of reward circuitry (Hagen et al., 2009, 2013; Hagen & Sullivan, 2018; Sullivan et al., 2008).

The paradox of drug reward

Plants, such as tobacco, evolved neurotoxic pesticides, such as nicotine, to harm and deter herbivores, not reward them. Herbivores, in turn, evolved to avoid consuming toxic compounds. It is paradoxical that neurotoxic drugs of abuse activate reward and reinforcement mechanisms in the brain and that humans have long deliberately sought out and consumed them.

Self medication: the biological roots of human “recreational” and other psychoactive drug use?

Much of human physiology functions to safely extract nutrients, such as lipids, carbohydrates, and proteins, from plant and animal foods. These are then delivered to various tissues along with sufficient quantities of oxygen to provide the energy and resources necessary to run and maintain the body. Plant toxins have always been an important component of the stream of plant foods that coursed through the bodies

of human ancestors on a daily basis. The diverse array of toxin defense mechanisms shows that plant toxins posed a considerable threat to physiological functioning, but could plant toxins also have provided benefits?

Plant toxins evolved to harm plant pathogens and predators, which include microbes, fungi, helminths, insects and other arthropods, and vertebrates. The same categories of organisms that eat plants also eat animals. It is therefore conceivable that humans and other animals evolved to deliberately seek out and ingest limited quantities of plant toxins to self-medicate their own infections. Self-medication, originally proposed as a nonhuman primate behavior, is now documented in diverse nonhuman species, including fruit flies, ants, moths, butterflies, honey bees, birds, sheep, and goats (see references in Hagen et al., 2013). There is also increasing evidence that Neanderthals self-medicated with plant and fungal toxins (Weyrich et al., 2017).

Plant neurotoxins, in particular, target organisms with nervous systems, such as helminths, insects and other arthropods, and vertebrates. Human psychoactive drug-seeking might be grounded in an evolved, albeit unconscious, strategy to self-medicate infections of helminths, ticks, fleas, and other macroparasites (Hagen et al., 2009; Sullivan et al., 2008). It is intriguing that most popular recreational plant drugs, including coffee, tea, tobacco, cannabis, and betel nut, are toxic to helminths, and in hunter-gatherers, tobacco and cannabis use is negatively associated with helminth infections (Roulette et al., 2014; Roulette, Kazanji, Breurec, & Hagen, 2016a). Some helminth species have a larval stage that migrates through the lung, which perhaps was a selection pressure specifically to smoke neurotoxic plants. There are also robust but poorly understood interactions between the immune system and drug use, which could be hints of an adaptation to detect and self-medicate infections (see Hagen, Roulette, & Sullivan, 2013, for a brief review).

Psychoactive drugs are also often used for performance enhancement. Nicotine and caffeine, for example, appear to improve attention and memory (Einöther & Giesbrecht, 2013; Rezvani & Levin, 2001). Hagen et al. (2009) proposed that plants might be under selection to produce toxins with these cognitive-enhancement properties. Toxic and venomous animals have evolved distinctive sounds, odors, or coloring, such as the hornet's black and yellow bands, to improve the ability of potential predators to notice, recognize, and remember them, so as to better avoid them, a phenomenon termed aposematism. Toxic plants are similarly under selection to improve attention and memory in herbivores, so that herbivores notice, recognize, and remember which plant caused the toxic reaction so as to stop eating it and more reliably avoid eating it in the future. But plants need not rely solely on activating herbivore sensory organs. Instead, because toxic plants are ingested, they could potentially achieve the same effects by evolving compounds that "[pass] through the blood-brain barrier to directly trigger attention, aversion, and other learning mechanisms in the CNS" (Hagen et al., 2009, p. 77). If so, this could explain why some psychoactive plant drugs enhance aspects of cognitive performance (Hagen et al., 2009; for further evidence for this hypothesis, see Ejsmond and Provenza, 2018).

Hallucinogens such as mescaline, dimethyltryptamine, and psilocybin and ergot alkaloids (found in numerous species of fungi) are also toxins, and their hallucinogenic effects are probably byproducts of their neurotoxic effects. Aposematism, however, might have had some role to play in their evolution. Aposematic organisms typically have striking coloration, or produce distinctive odors or sounds. Hallucinogens also generate striking visualizations and other sensory experiences, usually accompanied by symptoms of toxification such as nausea and vomiting, that might improve an herbivore's ability to notice, recognize, and remember the toxic plant or fungus, so as to stop eating it and more reliably avoid it in the future (unlike, e.g., coloration, however, hallucinogenic plants only generate sensory effects once consumed).

The neurotoxin regulation hypothesis

Herbivore foods are almost always infused with toxins and other plant secondary compounds. Because avoidance of toxins was impossible, herbivores, including members of the human lineage, should have evolved mechanisms to regulate their intake so as to avoid poisoning (Torregrossa and Dearing, 2009). If deliberate consumption of neurotoxic plants, which is extremely dangerous and potentially lethal, provided some fitness benefits to members of the human lineage, there would have been selection for neurophysiological mechanisms to maintain circulating levels of toxins by carefully regulating their intake and excretion. Psychoactivity, for instance, might itself be a cue of neurotoxicity that in some cases promotes consumption of neurotoxic plants (Hagen et al., 2009, 2013).

Salt intake provides a useful analogy. Many animals, including humans, seek out natural sources of salt and other minerals (Klaus & Schmidg, 1998). Prior to the discovery of sodium's role in body fluid homeostasis, our evolved appetite for salt was utterly mysterious. There are complex neuronal and endocrine mechanisms, including special salty taste receptors on the tongue, that regulate intake and excretion of milligrams of this valuable environmental chemical to maintain sodium homeostasis (Geerling & Loewy, 2008), even though there is no conscious awareness of its biological benefits. Similarly, bitter taste receptors and other xenosensors, in conjunction with neuronal, immunological, and other mechanisms, might regulate intake and excretion of milligrams of neurotoxins for their medicinal or social benefits without any conscious awareness of these benefits. Unlike the sodium regulation mechanism, however, the putative neurotoxin regulation mechanism must titrate a diverse range of compounds.

In support of regulated intake, cigarette smokers titrate nicotine, altering their smoking behavior in response to changes in nicotine content so as to maintain a relatively constant blood concentration of nicotine (Scherer & Lee, 2014). In support of regulated excretion of potentially therapeutic substances, whose levels should be maintained or increased when fighting an infection, there is a widespread down-regulation of xenobiotic metabolizing enzymes and xenobiotic transporters during infections (including helminth infections), mediated by inflammatory cytokines.

This dramatic downregulation of xenobiotic defense gene expression is poorly understood, although it might serve to ensure sufficient haptic resources for the acute phase response to infection, e.g., upregulated expression of C-reactive protein (Klein et al., 2015). Because its effect is to maintain or increase circulating levels of xenobiotics (Keller et al., 2016; Klein et al., 2015; Mimche et al., 2014; Morgan, Lee, & Nyagode, 2011), however, such as potentially therapeutic plant toxins, it is worth considering that it might (also) be part of an evolved neurotoxin regulation system.

The important role of cultural transmission

Many, perhaps most, organisms use individual learning, such as associative learning, to optimize their behavior to local environmental conditions (van Duijn, 2017). Individual learning carries a cost, however. To discover the optimal behavior, an organism must often attempt behaviors that are suboptimal or even detrimental. To individually learn which plants are edible, for example, herbivores must sample unknown plants, which will include toxic plants, and will thus pay the occasional price of getting sick. Social learning, i.e., cultural transmission, avoids the cost of individual learning. Socially learning which plants are edible by observing the food choices of knowledgeable individuals provides the benefit of safe foods without paying the cost of occasional toxification (e.g., Rogers, 1988). Plant food choice was undoubtedly one of the selection pressures for the evolution of social learning in the human lineage. Infants look to adults before touching a plant (Elsner & Wertz, 2019), for example, and pregnant women in traditional societies learn from their mothers, grandmothers, and mothers-in-law which teratogenic foods to avoid (Henrich & Henrich, 2010; Placek & Hagen, 2015; Placek, Madhivanan, & Hagen, 2017). If there was natural selection on the human lineage to deliberately consume neurotoxic plants for medicinal or other purposes, the resulting adaptations for regulated neurotoxin intake would certainly rely heavily on socially learning to identify substances that maximize the benefits of ingestion and minimize the costs.

Does drug teratogenicity explain age and sex differences in drug use?

Global surveys of the prevalence of recreational drug use find dramatic age and sex differences. There is almost no drug use by children under the age of 10. Between the ages of 10 and 20, there is a rapid, switch-like transition to drug use by both sexes. Almost all users of a particular drug will have started use by early adulthood (Degenhardt, Stockings, Patton, Hall, & Lynskey, 2016). See Figure 25.1.

Sex differences in drug use are more variable across populations, type of drug, age, birth cohort, and other factors. By and large, though, the prevalence of drug use is greater in males than in females for most substances at most ages (e.g., tobacco use;

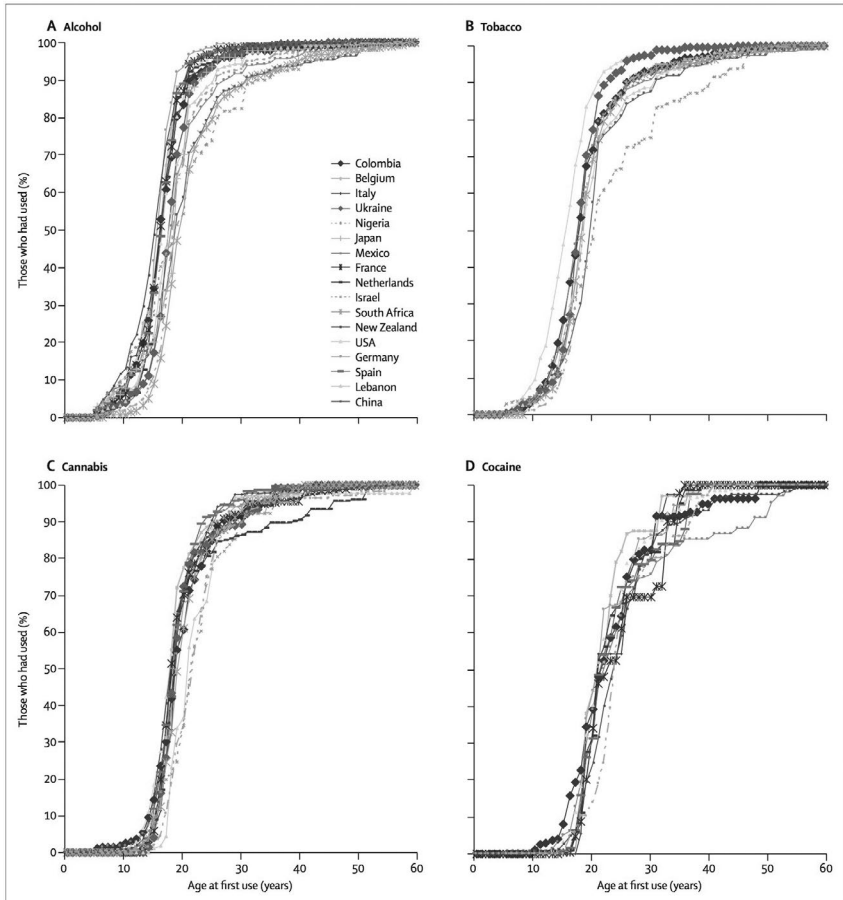


Figure 25.1 Cumulative distribution of self-reported age of first use of alcohol, tobacco, cannabis, and cocaine in a large ($n = 85,052$) cross-national sample of users of these substances. The similarities of these patterns across both drugs and countries suggest the existence of a developmental “switch” to drug use during adolescence.

Figure 25.1 is to be made available as a downloadable e-resource at www.routledge.com/9781138594500.

Source: Figure from Degenhardt et al. (2016).

see Figure 25.2), a sex difference that tends to emerge in late adolescence and early adulthood (for review, see Hagen et al., 2013).

The near absence of drug use in children is typically assumed to be due to parental and other societal restrictions. Although to our knowledge this assumption has never been empirically tested, it is reasonable for tobacco, which is subject to numerous forms of control, such as laws in many countries that prevent sales to minors and extensive advertising campaigns that warn about health hazards. It is much less

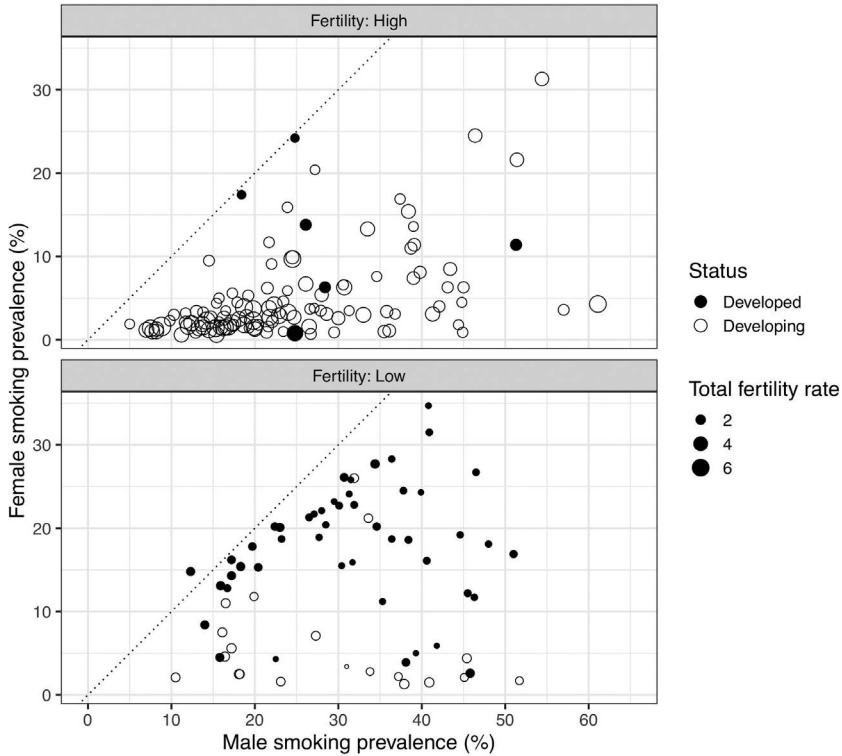


Figure 25.2 Prevalence of smoking by sex in 184 countries in 2012. Each dot is one country, and the size of the dot represents the total fertility rate (TFR). High fertility: $TFR > 2$; low fertility: $TFR \leq 2$. Dotted line: equal smoking prevalence. Countries below the line have a prevalence of male smoking that is greater than the prevalence of female smoking. The prevalence of female smoking is generally much lower in developing countries that tend to have high TFR compared to developed countries that tend to have low TFR.

Source: Smoking and country developmental status from Ng et al. (2014). Total fertility rate data from United Nations, Department of Economic and Social Affairs, Population Division (2015).

reasonable for caffeine, a bitter-tasting plant drug that shows promise as a pesticide and repellent for slugs, snails, birds, and insects, yet which is present in, or added to, many foods marketed to children, such as soft drinks, energy drinks, and chocolate. Despite children's ready access to caffeine, their consumption of caffeine is quite low compared to adults, and begins to increase in adolescence, just like consumption of other drugs (Hagen & Sullivan, 2018).

The sex difference in drug use is also widely thought to be due to societal restrictions on women's drug use. According to this view, differences in traditional sex roles translate into gendered social norms, such as disapproval of female drug use and social rewards for male rebelliousness and drug use. Cross-national variation in female smoking prevalence is similarly tied to cross-national variation in women's

social, political, and economic power, that is, to variation in gender inequality. In countries with high gender inequality, women might face considerable social and economic barriers to obtaining and smoking cigarettes, whereas in countries with low gender inequality, women might face fewer such barriers (Hagen, Garfield, & Sullivan, 2016; Hitchman & Fong, 2011). We refer to these ideas as the *social restriction model* of age and sex differences in drug use.

Alternatively, many plant defensive chemicals, including psychoactive plant toxins, are teratogenic, i.e., disrupt development (Panter, Welch, & Gardner, 2017). Nicotine, for example, is a teratogen that interferes with acetylcholine signaling, which has a unique trophic role in brain development. Nicotine exposure can disrupt all phases of brain assembly (Dwyer, Broide, & Leslie, 2008), and smoking during pregnancy causes poor fetal growth, and is associated with increased risk of number of other poor pregnancy outcomes, such as spontaneous abortions and stillbirths (Cnattingius, 2004). The costs of plant toxin ingestion are therefore higher for individuals whose brains and other organs are still developing, i.e., fetuses and children. There is considerable evidence that toxin defense mechanisms are upregulated in children and pregnant women. Infants are more hesitant to touch plants compared to other objects (Wertz & Wynn, 2014). Children are neophobic and picky about food, have a higher density of taste buds on the tip of the tongue, and are more sensitive to bitter substances. Women also have more taste buds than men, appear to have higher bitter taste sensitivity, and during pregnancy are averse to spicy foods and have upregulated activities in most xenobiotic metabolizing enzymes (Hagen et al., 2013).

According to the neurotoxin regulation hypothesis, then, the higher costs of exposure to plant teratogens suffered by children should reduce their drug consumption relative to other segments of the population. As the development of the brain and other organs nears completion, the costs of teratogen exposure are reduced, so drug consumption should increase (i.e., in adolescence and early adulthood). Similarly, pregnant women, and women in their reproductive years more generally, should have lower drug use compared to postmenopausal women and men. Because the transition to drug use occurs in adolescence and early adulthood (see Figure 25.1), an early transition to motherhood might preempt the transition to drug use. The reduction in female drug use should therefore be more pronounced in traditional (developing) populations with an earlier age at first marriage and first birth, and higher total fertility rates. Indeed, whereas the prevalence of male smoking is virtually identical in developing vs. developed countries (32% vs. 30.1%, respectively), the prevalence of female smoking is dramatically lower in developing countries (3.1%) than in developed countries (17.2%) (Ng et al., 2014). We refer to this view as the *developmental disruption model* of age and sex differences in drug use. See Figure 25.3.

In support of the developmental disruption model, Hagen et al. (2016) found that, controlling for gender inequality and per capita income, countries with higher total fertility rates (TFR) had lower female smoking rates. They also found that the prevalence of female smoking increased in older, postmenopausal women relative to younger women, and that this increase was greater in countries with high TFR (see also Roulette, Hagen, & Hewlett, 2016b).

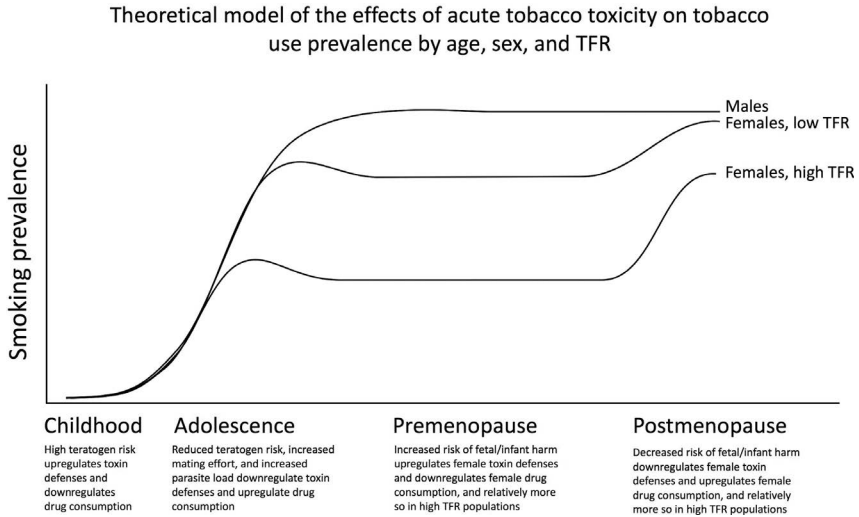


Figure 25.3 Theoretical model of age and sex differences in use of tobacco and other plant drugs; TFR: total fertility rate

Source: Figure from Hagen et al. (2016).

If the stark age and sex differences in psychoactive drug use seen in contemporary populations also characterized ancestral populations (but see the following text), then it is possible that conspicuous consumption of psychoactive substances could serve as social signals. For instance, the transition to drug use in adolescence could be an honest signal of developmental maturity, i.e., that one has transitioned from the juvenile to the adult phase of life, which is information that would be valuable to potential mates and other social partners. Conspicuous consumption by reproductive-age women might signal that they are not pregnant, information that is valuable to potential mates (Hagen et al., 2013).

Age and sex differences in drug use could be altered by the following factors: If the anti-parasitic or other benefits of drug use outweighed the risk of disrupted development, individuals might start using drugs at younger ages, or during their reproductive years. In addition, avoidances of toxic and teratogenic substances are often acquired by social learning. If a particular drug is not among the substances identified as dangerous during pregnancy by, e.g., mothers, grandmothers, or mothers-in-law, then women who are pregnant or in their reproductive years might not avoid it.

There is some overlap between the social restriction model and the disrupted development model of age and sex differences in drug use in that both involve authority figures, such as parents, warning against the use of psychoactive substances. In the case of the social restrictions model, however, there is either an implicit or explicit assumption that there is a conflict between the innately rewarding experience

of drug consumption regardless of age or sex and the warnings from authority figures who aim to prevent drug use by certain others despite often enjoying these substances themselves. According to the disrupted development model, in contrast, the interests of children and pregnant women are aligned with those of the authority figures, all of whom are keen to avoid developmental harm to the child or fetus, and there is a synergy between bitter taste and other cues of toxicity, and warnings from parents and trusted others.

Ethanol

Ethanol is a globally popular psychoactive drug that is not a plant toxin but is instead a metabolic byproduct of yeast metabolism. It would therefore seem to be a glaring exception to the foregoing theoretical framework, which emphasizes the co-evolution of the human lineage with neurotoxic wild foods.

Ethanol could be less of an exception than it seems, however, as it might have evolved to serve as a toxic defensive chemical for yeast. Adenosine triphosphate (ATP) is a critical molecule that provides energy for cellular processes. Yeasts can typically use two different pathways to produce ATP from sugars: respiration and fermentation. Respiration, which requires oxygen, metabolizes sugar to CO₂ to produce a high yield of ATP (e.g., 18 ATP per glucose in *S. cerevisiae*), whereas fermentation, which does not require oxygen, metabolizes sugar to ethanol to produce a low yield of ATP (e.g., 2 ATP per glucose). Interestingly, many yeasts, including *S. cerevisiae*, use fermentation even in the presence of oxygen, termed the Crabtree effect, resulting in a much lower yield of ATP than they would if they used respiration. Why would many yeasts have evolved to pay this price? One influential hypothesis is that ethanol is toxic to other microbes, such as bacteria, that are competing for the same sugars in fruit. Thus, instead of defending themselves with toxins, yeasts are defending their food supply (Piškur, Rozpędowska, Polakova, Merico, & Compagno, 2006). An alternative hypothesis for the Crabtree effect is that although the yield of ATP in fermentation is low compared to respiration, its rate of production is higher, which would provide a competitive growth advantage (Pfeiffer & Morley, 2014). The two hypotheses are not mutually exclusive.

Whatever the evolutionary explanation for the Crabtree effect, ethanol is a small, toxic organic molecule infusing plant foods, such as rotting fruit, and it therefore might trigger the same toxin defense mechanisms and putative neurotoxin regulation mechanisms as other plant neurotoxins (Sullivan, 2017). In support, the distribution of ages of onset for alcohol use is very similar to that of plant drugs (see Figure 25.1).

There is more to the story, however. Humans and other primates possess several genes for alcohol dehydrogenases (ADH), enzymes that metabolize alcohol to acetaldehyde, which suggests that the human lineage has long been exposed to alcohol, and that there was some fitness benefit to metabolizing it. Fruits, an important plant food, often ferment, and ethanol has more calories per gram than carbohydrates (7.1 vs. 4.1). Primates might have evolved to be attracted to ethanol both as a cue of food

and as food itself (Dudley, 2000, 2014). In a breakthrough, Carrigan et al. (2015) discovered that in early human ancestors prior to our divergence from orangutans, ADH4, the first enzyme exposed to alcohols in the digestive tract, was efficient at metabolizing long-chain alcohols that are common in plants, but it was quite inefficient at metabolizing ethanol. About ten million years ago, however, a mutation occurred in ADH4 in the lineage leading to the extant African apes that dramatically increased its catalytic activity for ethanol, but reduced its activity on long-chain alcohols. Carrigan et al. argue that around this time there was a shift to a more terrestrial lifestyle in this lineage, and fermenting fruit on the ground became an important fallback food. The change in ADH4 would have allowed more efficient exploitation of this ethanol-rich resource. Thus, ethanol might have been an important component of the diet in the human lineage for millions of years.

A further twist involves much more recent evolution of ADH in modern humans, as well as of aldehyde dehydrogenase (ALDH), which metabolizes acetaldehyde to acetic acid. Most research has focused on functional alleles of ADH1B, the alcohol dehydrogenase enzyme with the highest concentration in the adult liver. A derived allele that is at high frequency in modern East Asian populations (rs1229984), but low frequency in African and European populations, underwent recent positive selection that is geographically and temporally associated with the advent of rice cultivation, circa 7,000–10,000 ybp (Peng et al., 2010; Wang et al., 2016). The resulting enzyme has substantially higher activity metabolizing ethanol compared to the ancestral allele, and there is evidence of convergent evolution of the same allele in European populations (Galinsky et al., 2016).

Additionally, there is an inactive allele of ALDH2 (rs671) that is at relatively high frequency in East Asia and virtually absent elsewhere. Enzyme activity is greatly reduced in heterozygotes for this allele and abolished in homozygotes.

Several hypotheses have been put forward for positive selection on these ADH1B and ALDH2 alleles. Rice cultivation and storage in Asia were probably associated with both inadvertent and deliberate fermentation and increased consumption of ethanol. The effect of the ADH1B allele is to accelerate the formation of acetaldehyde, and that of the ALDH2 allele to inhibit the metabolism of acetaldehyde. The joint effect is therefore to increase levels of circulating acetaldehyde. Because acetaldehyde, like its chemical cousin formaldehyde, is highly toxic, one set of hypotheses proposes that these alleles were positively selected because acetaldehyde helps defend against infection by one or more pathogens (e.g., Goldman & Enoch, 1990). A more intensively researched hypothesis is that because acetaldehyde is responsible for many of the aversive effects of ethanol consumption, these alleles were selected because they deter alcohol use, thereby reducing the risk of alcoholism. Both alleles are, in fact, associated with reduced risk of alcoholism (for review, see Polimanti & Gelernter, 2018).

There are problems with both hypotheses, however. Whereas there is solid evidence of positive selection on the ADH1B allele, so far there is little compelling evidence of positive selection on the rs671 ALDH2 allele (Polimanti & Gelernter, 2018). If rs671 was not positively selected, this undercuts hypotheses that depend on

selection for increased levels of acetaldehyde. In addition, although the negative association of these alleles with alcoholism is large relative to other findings of genome-wide association studies, it explains little of the variance in alcohol use behaviors. Finally, ADH1B is expressed in many tissues and metabolizes many substrates other than ethanol, so positive selection on the ADH1B allele could be unrelated to ethanol metabolism. For a review, see Polimanti and Gelernter (2018).

Nevertheless, the most parsimonious hypothesis for positive selection on the Asian ADH1B allele is that, similar to the scenario described earlier for ADH4, the transition to agriculture increased exposure to ethanol, an environmental toxin (and nutrient), and there has subsequently been selection for increased ability to metabolize it. This hypothesis is supported by the facts that the Asian ADH1B allele increases enzyme activity, there has been convergent selection on the same allele in Europe, there is a similar African-specific allele of ADH1B (rs2066702) that also increases enzyme activity, and there seems to have been global recent positive selection on ethanol metabolic pathways (Johnson & Voight, 2018). The selection pressure might have involved ethanol's toxic effects. Ethanol is a teratogen (Goodlett, Horn, & Zhou, 2005), for instance, and its consumption has been generally (though not consistently) associated with pregnancy loss (Avalos, Roberts, Kaskutas, Block, & Li, 2014). Improved pregnancy and child developmental outcomes might therefore have been one selection pressure for improved ethanol metabolism during the transition to agriculture.

Archaeological evidence for prehistoric psychoactive drug use

Archaeology offers a deep time perspective into coupled human-plant interactions. While there has been a much greater emphasis on studies of plant for food (i.e., subsistence studies, domestication, and agriculture), a growing number of archaeologists are investigating evolutionary aspects of addiction and drug use by people, sometimes over very great time depths. The present status and use patterns of these substances have been influenced by thousands of years of co-evolution with human beings – and human manipulation seems to have enhanced the intoxicant properties of several of these plants, spreading them to areas where they may have not previously naturally occurred and in some cases leading to new species or domesticated varieties (e.g., tobacco).

As in modern times, humans have used an array of psychoactive plants not only as food but also for social, ceremonial, recreational, and medicinal reasons. Many societies have individuals, such as shamans, traditional healers, and doctors, who specialize in learning the medicinal benefits of toxic plants. Archaeologists often rely on early written records, explorer journals, and ethnographies to understand intoxicant plant use in traditional societies and interpret archaeological findings. From such records, coupled with a growing body of archaeological data, it is clear that intoxicant plants played (and continue to play) a central role in the ceremony and religion of many cultures.

Tracking ancient substance use

The widespread use of drugs and their importance in many cultures suggest that people *really like drugs*, and that they have liked them for a very long time. Firm evidence of psychoactive drug use in the past is possible through the identification of charred plant material, pollen, and other palaeoenvironmental data, but this can be complicated due to the rarity of charred seeds and costs of such analyses. The presence of certain ceremonial vessels, storage containers, and drug uptake-related artifacts (e.g., pipes, snuff trays) can signal use of intoxicant plants, and biochemical studies are increasing the precision with which we can identify prehistoric use of specific species or classes of plants. Chemical residue analysis and identification of alkaloid biomarkers via radioimmunoassay and, more commonly, liquid or gas chromatography–time of flight mass spectrometry (LC-TOFMS/GC-TOFMS) offer novel means of approaching these issues, and over the past 15 years a number of studies have produced compelling results demonstrating the global scale and deep time use of such substances.

Ancient roots of psychoactive drugs in shamanism and medicine

Shamanism is often associated with rituals involving out of body experiences, vision quests, and similar pursuits designed to connect individuals with spirit worlds through altered states of consciousness (ASC). ASC bring a heightened awareness or the sense of alternate realities to individuals and may be induced through a variety of means, including repetitive or trance-inducing percussion, fasting, withholding sleep, as well as the use of a wide array of hallucinogenic plants and substances (e.g., Carod-Artal, 2015; Torres, 1995). Some of the better known of these entheogens include datura (*Datura* sp.), peyote (*Lophophora williamsii*), *Anadenanthera* snuff, Belladonna (*Atropa belladonna*), blue lotus (*Nymphaea caerulea*), certain mushrooms (*Psilocybe* sp., *Amanita muscaria*), and bufotoxins secreted by some toads (*Bufo* sp.), but there are many others, and even great quantities of some potent species of tobacco are documented to have induced hallucinogenic states (Janiger & de Rios, 1976). *Ritual healing theory* suggests that such practices have very deep roots. In this line of thinking (see useful review in Sosis & Alcorta, 2003), early nonhuman primates engaged in rudimentary rituals (such as grooming) as a means of alleviating social stress; such rituals became increasingly complex as humans engaged in ASC and were common among hunting and gathering communities throughout the world (de Rios & Winkelman, 1989; McClenon, 1997). McClenon (1997, p. 345) argues that “shamanic/hypnotic suggestion may reduce pain, enhance healing, control blood loss, facilitate childbirth, and alleviate psychological disorders,” and thus ASC ritual offered evolutionary benefits for individuals “more responsive to such suggestions.” While intriguing, such behavior is difficult to track archaeologically and is not without controversy.

The “flower burial” at Shandihar Cave in northern Iraq, which dates to Middle Palaeolithic times (circa 60,000 BC), is widely regarded as the earliest possible

evidence of shamanistic intoxicant plant use in the world. The burial contained the skeleton of an adult male Neanderthal (*Homo neanderthalensis*) argued to have been a shaman, an idea largely based on the presence of a wide range of medicinal plant “pollen clusters” including the *Ephedra altissima*, a plant associated with the stimulant ephedra (Leroi-Gourhan, 1975; Lietava, 1992), though this has been disputed (Sommer, 1999).

Many regard European Palaeolithic rock art created by early *H. sapiens* as being associated with ASC and psychoactive drugs. In their neurological model of “entoptic phenomena,” Lewis-Williams and Dowson (1988) linked Palaeolithic art with ASC and drug use. The logic goes like this: Neurologically, human brains remained the same since Palaeolithic times, thus, people experienced ASC in the same way they do today, with abstract geometric patterns and visual hallucinations common (Sacks, 2012). In other words, “the abstract patterns and visual hallucinations created under ASC are universal, since they are effects of the central nervous system” (Guerra-Doce, 2015, p. 97). However, this line of thinking is not without debate (e.g., Guerra-Doce, 2015); see also *Current Anthropology* commentaries following Lewis-Williams and Dowson (1988). After the Neolithic there is increasing evidence of ancient drug consumption in many parts of Europe and Asia, for example, through the presence of artifacts interpreted to be associated with the consumption of plants such as opium (*Papaver somniferum*) and cannabis.

Since they first colonized the New World 14,000 or more years ago, Early Americans likely used psychoactive plants for medicinal, ceremonial, and shamanistic reasons. In the absence of chemical and archaeobotanical evidence, many researchers who track ancient use rely on the same logic linking Old World Palaeolithic art with ASC and drug use, as well as a rich ethnographic record linking certain artifact types, designs, and the like with shamanism and ritual drug use. This includes studies that posit that rock art and some types of painted and decorated ceramics are associated with datura and tobacco shamanism (Litzinger, 1981; VanPool, 2009). If taken in large doses, tobacco, a very common intoxicant plant used throughout the Americas (see the following text), can cause ASC experiences, hallucinations, and visions, and is documented as having been sought after for its mind altering effects by shamans for vision quests, curing, and other religious purposes (Janiger & De Rios, 1976; Siegel, 1989; Wilbert, 1987). In South America wooden “snuff trays” and tubes signal anadenanthera snuffing practices in South American shamanism (Torres & Repke, 2014), although identifying key chemical compounds associated with the plant has proven difficult in at least one study (Echeverría & Niemeyer, 2013).

Ethanol and fermented beverage consumption

Fermented beverages are commonly associated with ceremony, feasting, and ritual practices in different areas of the globe. Production of ethanol-containing drinks is a relatively straightforward process that was discovered independently by ancient peoples in different parts of the world. Archaeologists track the development of fermented beer, wine, and grog through early written records

and hieroglyphics, and in a growing number of studies, through chemical and archaeobotanical analysis.

China has the longest established records of fermented beverage consumption. Written records of millet and barley or wheat based beer production occur as early as the Shang dynasty in China (circa 1,250–1,046 BC) (Wang et al., 2016; Zhang, 1994). A study of Chinese ceramics dating to as early as 700 BC identified residues suggesting the artifacts were associated with a concoction of “rice, honey, and fruit (hawthorn fruit and/or grape)” and that such drinks “paved the way for unique cereal beverages used in later times” (McGovern et al., 2004, p. 17593). A multi-proxy record of starch grain, phytolith, and chemical data associated with a “beer-making tool kit” (ceramic pots, funnels, amphorae) discovered in northern China reveals an ancient beer “recipe” consisting of barley, broomcorn millet, Job’s tears, and tubers, and supports a much earlier (5,000-year) record of beer production in China (Wang et al., 2016).

Later dating but no less revealing studies have employed chemical trace analysis to track grog consumption in Nordic Europe (McGovern, Hall, & Mirzoian, 2013), herbal medicinal wines in Egypt (McGovern, Mirzoian, & Hall, 2009), and a 2,500-year-old record of grape wine production in southern France, an industry that possibly set the stage for the spread of wine in other parts of Europe and the world (McGovern et al., 2013). Tree resin additives were common in the ancient world and served to protect against “wine disease,” to cover “off-tastes and off-aromas,” as well as for medicinal purposes. Similarly, herbs such as rosemary, mint, thyme, and mugwort were often added to wines and beers in ancient Egypt, China, and Etrusca, for medicine and taste (McGovern, 2010; McGovern et al., 2009, 2013). As one leading scholar of the archaeology of fermented beverages put it, “ancient wine . . . served as more than a social lubricant or aromatic beverage, as is customary today. In addition to its eventual role as a powerful religious symbol, grape wine and other alcoholic beverages were the medicines of antiquity. . . . alcoholic beverages were an excellent means to dissolve and administer botanical concoctions externally and internally” (McGovern et al., 2013, p. 10151).

Evidence for fermented beverages is largely absent in North America, but South American examples include archaeological studies of ancient chicha (maize) beer drinking in the Peruvian Andes via plant microfossil studies (Logan, Hastorf, & Pearsall, 2012). Archaeological studies suggest the possibility of ancient fermented cacao drinks in addition to better known “chocolate” drinks (see next section). For example, Henderson, Joyce, Hall, Hurst, and McGovern (2007) found that ceramic vessels from the Puerto Escondido site in Honduras differ significantly in form from later Classic period vessels. Earlier dating pots do not seem to facilitate frothing (associated with traditional Mesoamerican style chocolate drinks), so the study authors hypothesize that they may have been associated with another cacao preparation method, such as a fermented beverage. Fermented cacao is also suggested in some hieroglyphics on Classic Maya polychrome vessels, which refer to “tree-fresh” cacao, which evokes the concoction resulting from the initial period of fermentation from the pulp of the cacao pod (Stuart, 2006). While intriguing, the use of fermented cacao drinks has yet to be confirmed chemically.

Stimulants: ancient performance enhancers?

Ancient stimulants include a wide range of products including coffee (thought to originate in Ethiopia), oolong and many other teas (Asia), betel nut (Southeast Asia), tobacco (North and South America), coca (South American Andes), cacao or chocolate (*Theobroma cacao*, South America, Mesoamerica, southwestern US), and cassina (*Ilex vomitoria*) (southeastern United States). Coca is used by many people living in the South American Andes. Several studies including Cartmell, Aufderheide, Springfield, Weems, and Arriaza (1991) and Rivera, Aufderheide, Cartmell, Torres, and Langsjoen (2005) have confirmed a 2,000–3,000 year record of coca use via the detection of biomarkers including benzoylecgonine (BZE), a metabolic product of cocaine in the hair of male and female burials.

Some stimulants were associated with high status ceremonials and purgative rituals. Cassina and cacao were derived of psychoactive plants used in elite ceremonials in North America. Chemical evidence tracing the ritual use of these plants archaeologically has been a major emphasis in recent years, and based on such work it seems clear that both cacao and cassina were highly esteemed ceremonial drink plants used by elites for hundreds if not thousands of years (e.g., Crown et al., 2012; Crown & Hurst, 2009; Henderson et al., 2007; Washburn, Washburn, & Shipkova, 2011).

Traditionally reddened teeth associated with betel nut chewing was seen as a mark of beauty among many societies in Southeast Asia. Betel nut chewing involves a mixture of limestone paste, areca nut, Piper betel vine leaves, and sometimes tobacco (in more recent times). Archaeological evidence of the practice includes archaeobotanical remains of betel vine and areca found at a site in Timor dating to as early as 13,000 years before present, and numerous cases of stained teeth in human burials at sites throughout the region dating to after 5,000 years ago (Fitzpatrick, Nelson, & Reeves, 2001).

Pathways to domestication? The origins of tobacco and cannabis ritual

Tobacco (*Nicotiana* sp.) and cannabis (*Cannabis* sp.) are thought to have been some of the earliest cultivated plants in the world. Cannabis is thought to have evolved in the steppes of central Asia (Mongolia and Siberia) possibly 12,000 years ago, and later spread throughout the Asian and European continents. As with tobacco in the New World, cannabis is thought to have been one of the earliest plant cultigens in the Old World. There is some debate about when cannabis was first used as a psychoactive, however. Cannabis plant parts have been found in early archaeological sites, but in many cases may have been associated with non-psychoactive use; hemp or non-psychoactive cannabis has a variety of uses, especially as a fiber for cloth, paper, and rope/cordage, and continues to be used by many groups for such purposes to the present day. Palaeoenvironmental and archaeological evidence reveals an 8,000-year record of cannabis use throughout Eurasia, though an increase in key markers suggests an increase in psychoactive use around 5,000–4,000 years ago (Long, Wagner,

Demske, Leipe, & Tarasov, 2017). Psychoactive use is strongly suggested by the presence of numerous cannabis plants/plant parts in tombs found in the Turpan Basin of Central Eurasia, including a remarkable 2,800–2,400 year-old burial of a man who was shrouded in 13 complete cannabis plants (Jiang et al., 2016).

Tobacco has New World origins and is thought to have been first domesticated in the Andes region of South America about 6,000–8,000 years ago (Goodspeed, 1954; Winter, 2000a). At contact, numerous tobacco species were used by indigenous peoples throughout the Americas who regarded it as a sacred plant with great power. Winter (2000a) hypothesized that tobacco was not only the earliest domesticated plant in the Americas, perhaps even predating and setting the stage for maize agriculture, but one of the first plants used by the initial colonists of the Americas. In this scenario, early Ice Age hunter-gatherers came from Siberia around 13,000 years or more ago, and this was a place with an existing complex of shamanistic practices and medicinal plant use. Early groups would have readily recognized the special qualities of tobacco and thus were likely to have adopted the plant quite early in time.

Domesticated tobaccos such as *N. rustica* and *N. tabacum* were used primarily by farmers throughout South America, Mesoamerica, the Caribbean, and the eastern US, while hunter-gatherer fishers used numerous indigenous (coyote) tobacco species (Figure 25.4a). While once regarded as a largely “wild” species, it is clear that hunter-gatherers regarded tobacco as a special plant, and cultivation practices seem to have resulted in new tobacco varieties as well as anthropogenically extending tobacco to places far outside of its natural range (Turner & Taylor, 1972; Tushingham & Eerkens, 2016).

At contact tobacco was ingested in a variety of ways – through snuffing, chewing, eating, and smoking (in pipes, cigars, and cigarettes) and by enema. Of these techniques smoking in pipes is the most likely to be recognized archaeologically. Archaeological pipes (Rafferty, Lednev, Virkler, & Chovanec, 2012, refers to them as “nicotine delivery devices”) are an innovation that dates to as early as 4,000–5,000 ybp in North America, but they become much more common after approximately 2,000 years ago. In any case, without direct chemical or archaeobotanical evidence it should not be assumed that people used the pipes at all times and in all places to smoke tobacco since historic native groups in North America smoked 100 or so different species of plants, including tobacco (Moerman, 1998). To date the earliest chemical evidence of tobacco use via the identification of nicotine in pipes is associated with artifacts in the eastern US (Carmody et al., 2018; Rafferty, Lednev, Virkler, & Chovanec, 2012), but biochemical discoveries in northwestern North America are demonstrating deep time continuity of tobacco smoking and possibly cultivation practices by hunter-gatherer-fishers, including the far interior Northwest, a region where tobacco was previously depicted as being introduced by traders and explorers after contact, demonstrating deep time continuity of indigenous tobacco smoking in a place where tobacco has been depicted as being introduced by early Euro-American traders and explorers (Tushingham et al., 2013; Tushingham et al., 2018b) (Figure 25.4).

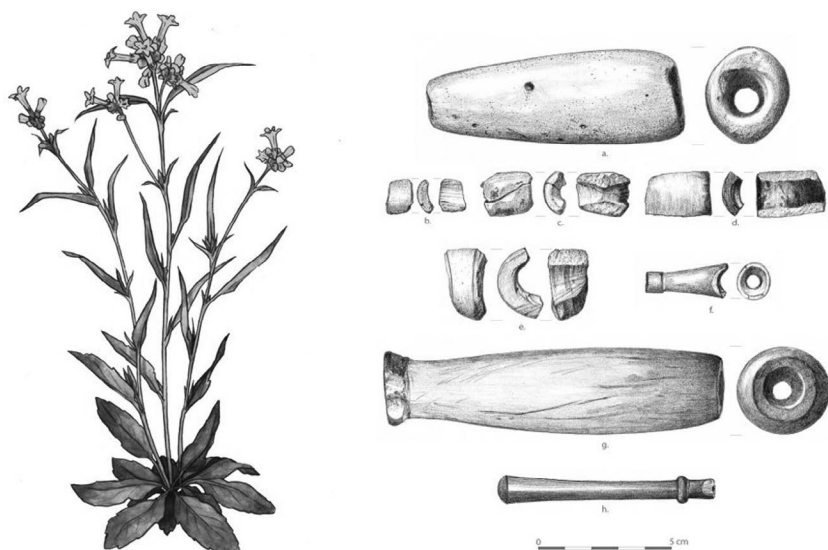


Figure 25.4 Tobacco, often smoked in pipes, was a widespread intoxicant plant used by indigenous groups throughout the Americas for thousands of years. Image at left: *Nicotiana quadrivalvis*, a preferred indigenous tobacco species widely used by hunter-gatherer-fisher groups in western North America (illustration by Emily H. Hull). Image at right: the northernmost biochemical evidence of pre-contact tobacco use is represented by these nicotine positive pipes from archaeological sites in the northwestern Plateau (illustration by Tammara Norton; see Tushingham et al., (2018b).

Figure 25.4 is to be made available as a downloadable e-resource at www.routledge.com/9781138594500.

Ancient gender and age patterns of drug use

While the vast majority of archaeometric studies work with residues extracted from archaeological artifacts, recent innovations have made it possible to identify drug alkaloids in the human hair of mummies (Cartmell et al., 1991; Echeverría & Niemeyer, 2013; Niemeyer, de Souza, Camilo, & Echeverría, 2018; Rivera et al., 2005) as well as the dental calculus (mineralized plaque) scraped from ancient human teeth (Eerkens et al., 2018; Tushingham et al., 2018a). When coupled with demographic data about individual burials (e.g., age, sex, health, status based on grave goods, etc.) these innovations are giving archaeologists an unprecedented window into understanding drug use patterns in ancient societies.

Tobacco use is a major focus in recent chemical studies of human hair and dental calculus, and several of these studies are providing insight into several evolutionary models reviewed earlier, for example, those positing that avoidance of plant toxins is an evolved response by women of reproductive age (to protect fetuses and nursing infants from harmful biochemicals) and younger children (to avoid deleterious growth effects). If true, tobacco use should be reduced in children and reproductive

age women compared to adult men and post-reproductive women (Hagen et al., 2016; Roulette et al., 2014). See Figures 25.2 and 25.3.

Tobacco's harmful effects on infants are well-known today, a fact that is reflected in one provocative study from South America, where Niemeyer et al. (2018) identified nicotine and cotinine in a chemical analysis of hair from a perinate from northern Chile. Quantitative segmental hair analysis suggested the perinate died shortly after or during delivery, leading the authors to posit that the mother consumed very high quantities of tobacco and thus was a "tobacco shamaness" who "might have experienced a miscarriage, since tobacco consumption by pregnant women is strongly associated to spontaneous abortions and perinatal death" (Niemeyer et al., 2018, p. 130). It is indeed a puzzle why a pregnant woman would ingest so much tobacco, as the deleterious effects on infants must have been known by prehistoric people. However, it is unclear whether this was an anomaly, or if there was some other reason. Tobacco is documented as a "strong medicine," used to treat a wide range of ailments (e.g., Groark, 2010, pp. 14–16; Stewart, 1967), as well as an abortifacient (Breedlove & Laughlin, 1993; Noumi & Djeumen, 2007). Thus, although speculative, it is possible the woman had ingested high amounts of tobacco because it was used to treat a serious illness, because she had or was in the process of having a miscarriage and was ingesting tobacco to speed the process along, or simply because she no longer wanted to bring her child to term.

The greater frequency of dental calculus in the archaeological record (preserved human teeth are much more common than preserved human hair) is giving archaeologists an expanded understanding of tobacco use in larger populations. A pilot study investigating patterns of tobacco use in pre-contact Native American populations analyzed dental calculus samples from burials excavated from sites in central California (Eerkens et al., 2018). Nicotine was identified in 2 of the 10 analyzed samples, a male and an older female, providing support for the evolutionary models reviewed earlier. However, a follow up study is providing mixed results: Tushingham et al. (2018a) identified nicotine in 7 of 60 tested dental calculus samples from another central California site, but the researchers were surprised to discover that the majority (6 of the 7) of the samples were associated with females, suggesting women may have been more commonly tobacco users than the ethno-historic record would suggest. Also, tobacco use was not as age restricted as expected, with nicotine positive female burials including overlapping estimated individual age ranges from 20–25, 25–34, 30–34, 40–45, and 40–44 years of age, at the time of death.

Unfortunately, at least at this point, it is difficult to say much about degree of use. In other words, although the chemical evidence tells us that these women were tobacco users, we do not know enough about the process of uptake and preservation of nicotine in dental calculus to know much about the *amount* of tobacco they were using. Tushingham et al. (2018a) suggest the women were tobacco chewers since most of their nicotine positive teeth were in posterior areas of the mouth (versus males who tended to have positive anterior teeth, possibly a sign of pipe use). It could be that women were chewing relatively low amounts of tobacco as self medication or performance enhancement (see the preceding text), for example,

as a mild stimulant on a daily basis, high enough to reach the limits of detection by archaeologists, but too low to adversely impact unborn children.

In addition, mortality rates in such populations are highest among young children and the elderly, and lowest among those of reproductive age (e.g., Burger, Bau-disch, & Vaupel, 2012). Thus, the presence of young adult women in this sample is somewhat unusual. Perhaps they were severely ill, and self-medicating with tobacco. There are many challenges to inferring the distributions of health and health-related behaviors in prehistoric populations from skeletal samples, however (the so-called osteological paradox; DeWitte & Stojanowski, 2015; Wood et al., 1992). The apparent use of tobacco by reproductive age women should therefore be interpreted cautiously. Nevertheless, there are contemporary high fertility populations in which the prevalence of female tobacco use is relatively high (see Figure 25.2).

It is interesting that ethnohistorically, tobacco was both smoked and chewed with a mixture of shell lime in many places in central California (Winter, 2000b), and among the Yokuts of this area, most men and women drank a “lime and tobacco emetic” in winter months for fasting purposes and to “dream of supernatural beings” (Winter, 2000b, p. 35). Additional research is clearly needed to flesh out these patterns, and work is currently underway that involves studies of the dental calculus of modern drug users (to better understand preservation dynamics and expand ancient dental calculus studies to other drugs in addition to tobacco), in addition to significantly expanding sample sizes of archaeological studies, in terms of both number of archaeological sites and individuals analyzed.

While few adults today have not used or been impacted by one or more of the substances discussed in this chapter, few realize the deep time history of humanity’s interactions with these plants. In many cases, psychoactive plants used by prehistoric humans have in recent times been refined into incredibly potent and addictive substances, with profound global health consequences. Studies that investigate the evolutionary history of psychoactive drug use by humans provide a deep time perspective on addiction, self-medication, and other complex cultural and physical interactions of psychoactive substances.

Concluding remarks

For hundreds of millions of years, human and other lineages of plant-eating animals were exposed to dietary toxins, including neurotoxins, on a nearly daily basis, as evidenced by the evolution of extremely sophisticated and effective toxin defense mechanisms such as the blood brain barrier and other barrier tissues, large families of genes for bitter taste and other xenobiotic-sensing receptors, xenobiotic metabolism enzymes, xenobiotic transporter proteins, and aversive learning circuitry in the CNS that is triggered by toxin exposure. The archaeological record provides increasing evidence that deliberate human psychoactive substance use is not simply a modern phenomenon. The correct evolutionary explanation for human psychoactive substance seeking is not yet known. Self-medication, a behavior documented in many other species, is one promising hypothesis, however, especially since the medical

use of plants is ubiquitous across cultures and there is increasing evidence for self-medication in the archaeological record.

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26

THE LURE OF DEATH

Suicide and human evolution

Nicholas Humphrey

A late Roman ivory casket, in the British Museum, shows in sculpted relief two contrasting examples of humans who knowingly brought death on themselves (Figure 26.1) – Jesus, who had no desire to stop living, but who believed his death would benefit all mankind; and Judas, who had no thought of benefitting others, but who wanted to end his own intolerable guilt.

Suicide used to be called self-murder, *felo de se*. In an evolutionary context the term “murder” is not inappropriate. Human beings have always been killers of other living beings – first, of course, killers of animal prey for meat, but more significantly killers of other men and women. While not every ancient human would have had first-hand experience of assassination, everyone would have known and talked about it. Then, at some point, the idea must have dawned. Here is how the psychiatrist Erwin Stengel has put it: “At some stage of evolution man must have discovered that he can kill not only animals and fellow-men but also himself. It can be assumed that life has never since been the same to him” (1969, p. 37).

The purpose of this chapter is to consider just how radically life changed. I argue that the human mind must have had to evolve to a critical level of sophistication before anyone could have arrived at the idea that “I can kill myself.” However, from then on, suicide would never have been far from people’s thoughts. When times were hard, some individuals would have been bound to see death as an attractive option. Yet killing themselves would usually – if not always – have been a maladaptive act. I explore how this played out historically, and what remedies, if any, were available.

What is involved in the idea that “I can kill myself”? It is simple enough to say it, but the thought of killing yourself will usually have complex layers. Clearly it has to begin with imagining the act: You have to have a picture of how it can be done. Stengel implies that early humans acquired this from observing how animals and fellow-humans could be killed. But this hardly seems probable. The fact is that most



Figure 26.1 Panel from an ivory casket: the Crucifixion of Christ; late Roman, AD 420–430.

Figure 26.1 is to be made available as a downloadable e-resource at www.routledge.com/9781138594500.

Source: Copyright The Trustees of the British Museum.

of the ways you might observe to be effective for killing another – be it with teeth or claws or fists or clubs – would not be feasible ways for you to kill yourself. Instead, for most of human history (until the advent of modern murder weapons such as guns), a more likely model for suicide must have been accidental death: falling from a cliff, drowning in a lake, bleeding to death from a cut. By imagining yourself in the victim's place, you would see that what happened to him or her by accident could happen to you by your own intent. You might still want confirmation that it can really be done. But for this you might not have to look far. In a typical human community, where suicide is already prevalent, you will have heard tell of others who have successfully killed themselves. Humans as a species are notoriously imitative. Perhaps every suicide is at some level a “copy-cat suicide” (which I will return to later in the chapter.)

But now, to go deeper: When you think “I can kill myself,” who is this “self” and what do you imagine will result from “killing” it? Again Stengel implies that early humans would have understood the inevitable consequences of self-killing from observing the killing of others. Bodily death, however caused, has effects that anyone can see and take on board. There is the obvious bodily decay. But the most salient change is in the dead person's role as an actor in the physical or social world. The

rule is that they will not be coming back. This is a fact of death that some nonhuman animals with developed social skills can also understand up to a point. Frans de Waal describes how, when a group of chimpanzees in the Arnhem Zoo were shown a video film of the alpha male, Nickie, who had died by drowning two years earlier, his erstwhile rivals panicked as if they had seen a ghost (1983). By applying this rule to your own case, you would realize that you yourself once dead will no longer participate directly in the lives of others.

But we must go deeper still. For there is, of course, another meaning of “self,” and hence the probability that self-killing will have a still more significant result. When your body dies, what happens to your mind? Once you are no longer an actor in the public realm, can you no longer be a thinker or feeler in the private one? This is not, of course, something you or anyone else can discover from direct observation. But it is perhaps something you can deduce from circumstantial evidence. As a human, with a “theory of mind,” you expect to be able to infer another person’s mental state from their outward behavior. When, now, you observe that an individual’s body no longer behaves in any way at all – it neither acts spontaneously nor reacts to your probes – you have very good reason to suppose there is no longer anyone at home inside. True, absence of evidence is not entirely reliable as evidence of absence. But actually you yourself have had plenty of direct experience of your own mind going absent at a time of pseudo-death. When you fall asleep and your body becomes motionless and unresponsive, you know for a fact that your mind temporarily vanishes. You may remember how as a child you cried yourself to sleep, and found blessed relief in the ensuing oblivion.

Thus, kill yourself, and the result will be that in every important respect you will have removed yourself from the world. Like the parrot in the famous Monty Python sketch, once dead, you will have ceased to be; you will be an ex-human being.

So, to return to Stengel, “at some stage of evolution” humans made this momentous discovery. I hesitate to put a date on it. But given the cognitive skills required – “what-if” reasoning, self-awareness, time travel, theory of mind – I would say no one would have been able to make the discovery until about 100,000 years ago. Soon after that, however, just about everyone was able to make it. And since then “life has never been the same.”

The question is what the practical impact would have been. There seems no reason to doubt that the thought of self-killing would soon enough have been translated into action. Some of those who discovered they could kill themselves would have chosen to kill themselves. Suicide leaves no trace in the archaeological record. But modern day statistics presumably throw light on past history (WHO, 2014; Weissman, 1999). Today no fewer than 1.4% of all deaths worldwide are attributed to suicide, making it the world’s leading cause of violent death. Across the world more people die from suicide than from all wars and homicides combined – some 800,000 a year. Many more make the attempt. Of the world’s population, 2.7% have tried to take their own lives. Even more plan it. Fourteen percent report having had suicidal ideation at some stage.

These figures are enough to make any demographer sit up and wonder. How could self-destructive behavior on this scale have been persisting at such a high frequency? What does this suggest about the effects – good or bad – of suicide on human fitness? Common sense would say that self-killing must be the ultimate disadvantageous act, a sure path to genetic oblivion. But maybe this is wrong. Could suicide be biologically adaptive after all?

As I implied at the outset, there would seem to be two broad classes of suicide, distinguished by their motivation: those concerned with benefiting other humans, and those concerned with benefiting primarily the one who dies. We can call these, as Émile Durkheim did (but without necessarily buying into his theoretical framework), “altruistic” and “egoistic” suicide. I want to suggest they can be distinguished at another level: They correspond to the two different conceptions people have of what their death will immediately achieve.

When someone kills themselves in order to remove their bodily person from the world, it would seem quite plausible that they believe the knock-on effects will improve things for others. Jesus dies on the cross in the hope that by this public sacrifice he can bring about the salvation of all mankind. Or, for a more straightforward example, Captain Oates stumbles out from his cabin to die in the snow in the hope that, by relieving other members of Scott’s polar expedition from the burden of supporting him, he can give them a better chance of survival.

This is altruistic suicide. Could it be biologically adaptive? It clearly could be if it does in fact benefit the subject’s kin or social group. In one of the earliest statements of the principle of kin-selection Haldane is reported to have said: “I would gladly give up my life for two brothers or eight cousins” (1975, p. 496). Humans do not, like some social insects, have a propensity for specific acts of suicide hard-wired into their brains. But humans are nonetheless genetically primed with feelings of love and obligation for family and friends. Many theorists accept this could partly explain why humans are willing to sacrifice themselves for the common good – in times of famine, or plague or war. It might also help explain cases of apparent “suicidal generosity,” as when individuals choose to die – or even submit to being ritually killed – when they have become too old and decrepit to carry on. By relinquishing their bodies in such circumstances they could certainly be adding to their inclusive fitness. So there might indeed be positive selection for psychological traits that abet the decision (Joiner, Hom, Hagan, & Silva, 2016).

What about, however, when someone kills themselves in order to remove their *own mind* from the world? Then it is in no way plausible that they are thinking of benefiting others. The much more likely motive must be that they believe they themselves will be better off as a result. Thus Judas Iscariot hangs himself because he cannot live with his internal sense of shame. An Indian chieftain’s daughter jumps to her death from a cliff rather than marry a man she does not love. A businessman drowns himself when his company fails.

This is egoistic suicide. And it is in many ways the opposite of altruistic. Far from wanting to help others, these self-killers are thinking primarily of personal escape. They either do not care about the effect on others, or sometimes even intend some

kind of vengeance. And, whether they intend it or not, the effects on family and friends are often devastating.

Now, from an evolutionary viewpoint, here is the problem. Across the world the great majority of suicides are egoistical. Anthropologist Charles MacDonald, reviewing the motives for suicide, concludes: "A cross-cultural comparison shows that grief over, and conflict between closely related people, together with sheer physical pain and discomfort, cause or promote suicide more often than any other circumstances" (2007, p. 427). "The victims simply want to go. They don't mean to change things . . . The suicide wants to stop hurting" (MacDonald, 2003, p. 221). Edwin Schneidman, from a clinician's perspective, observes that the common goal of suicide is cessation of consciousness. He writes: "the idea of cessation – that you can be free of all your problems, get out of this mess, cancel your debts, release yourself from this anguish, stop this disease is the turning point in the suicide drama" (1980, p. 13).

Could this type of suicide possibly be adaptive? Surely no amount of special pleading could make it so. Many of those who do it are young. Across the world, it is the second most common cause of death in teenagers. If these young people had not died by their own hand, they would almost certainly have gotten over the hurt and gone on to make a success of their lives. At a stroke they have ruined their own fitness and that of related individuals too. At the level of biology, egoistic suicide is clearly a mistake, a path to genetic extinction.

So, what is going on? How can it be that so many continue to die this way? The authors I have just quoted point to the obvious explanation. Yes, it is indeed a biological mistake. But it is precisely because humans rise above biology that they can make this mistake. For, at a rational psychological level it is not a mistake at all. Humans like all animals have an instinctive drive to escape from pain, emotional as much as bodily. When they experience "psychache," as Shneidman (1993) calls it, when they feel sad, jealous, unloved, or inadequate, they will do whatever it takes to make these feelings go away. But for humans, unlike animals, the question of how to escape has been left open to reason. Given their insight that killing themselves will put an end to their suffering, suicide can seem to provide a perfectly rational solution: a reliable method of *self-euthanasia*. Nothing hurts less than being dead.

Moreover, when other possible escape routes would involve time and effort, suicide can seem to provide a solution that is quick and easy too. It may, as we noted earlier, require intelligence to think of it, but its realization can be simplicity itself. It requires no special expertise to leap from a cliff, to drink poison, or to slit one's wrists. In parts of Asia, people are known to "hang" themselves simply by kneeling and leaning into the rope (MacDonald, 2003, p. 208).

Susan Sontag has written: "How thin the line between the will to live and the will to die. How about a hole . . . a really deep hole, which you put in a public place, for general use. In Manhattan, say, at the corner of Seventieth and Fifth. A sign beside the hole reads: 4 PM – 8PM/MON WED & FRI/SUICIDE PERMITTED. Just that. A sign. Why, surely people would jump who had hardly thought of it before" (1992, p. 116). And indeed, real suicides are often unplanned and impulsive.

A survey of 306 Chinese patients who had been hospitalized following a suicide attempt found that 35% had contemplated suicide for less than ten minutes and 54% for less than two hours (Hvistendahl, 2012). In the United States “among people who made near-lethal suicide attempts, 24% took less than 5 minutes between the decision to kill themselves and the actual attempt, and 70% took less than 1 hour” (Miller & Hemenway, 2008, p. 989).

Schneidman’s term “psychache” may suggest major distress. But the precipitating causes for impulsive suicide can actually be astonishingly trivial. A recent review in *Science* about suicide in otherwise normal people opens with this example: “A young mother and loyal wife, Mrs Y showed none of the standard risk factors for suicide. Villagers said she exuded happiness and voiced few complaints. But when a neighbor publicly accused Mrs Y of stealing eggs from her henhouse, the shame was unbearable. Mrs Y rushed home and downed a bottle of pesticide” (Hvistendahl, 2012, p. 1025). In 2016 Jacintha Saldhana, a nurse in charge of Princess Kate Middleton in a London hospital, hanged herself, a day after accepting a hoax telephone call from a radio station. In the new world of social media, it is all too common for a schoolgirl to overdose on sleeping pills because she is being bullied on Facebook.

So, people kill themselves “when they want to go”: sometimes after careful reflection, sometimes on the spur of the moment, sometimes for profound reasons, sometimes for shallow ones. Hamlet asks: “who would bear the whips and scorns of time, the oppressor’s wrong, the proud man’s contumely, the pangs of despised love, the law’s delay, the insolence of office, and the spurns that patient merit of the unworthy takes, when he himself could his quietus make with a bare bodkin?” The answer is evidently: by no means everyone.

The trouble is, everyone has moments of despair. It is a grand, if tragic, truth about the human condition that – just because humans have so much higher ambition than other animals – hurting is bound to be a part of life. The poet Cesare Pavese said it explicitly: “everyone has a good reason for suicide” (Alvarez, 1971, p. 99). The philosopher Wittgenstein once told a friend that “all his life there had hardly been, a day, in which he had not thought suicide a possibility” (Edmonds & Eidinow, 2002, p. 155). More typically, among recent American high school students, 60% say they have considered killing themselves, and 14% have thought about it seriously in the last year (Garland & Zigler, 1993). George Santayana (1905) spoke for too many when he wrote: “That life is worth living is the most necessary of assumptions and, were it not assumed, the most impossible of conclusions.”

We have to stop to consider. Humans have *evolved* to this point: a point where a significant number live near the threshold of a self-generated catastrophe. Surely, this cannot be where evolution has rested. If the threat is as great as I have suggested, would not natural selection have come up with ways of countering it? Why have humans not evolved to have better innate defenses against suicide built into their minds?

There is, of course, one level of defense we might expect to have been there from the beginning. This is a natural *fear of death*. Miller (2007) has written: “There is no way to escape the hardwired fears and reactions that motivate humans to avoid

death. Suffocate me, and I'll struggle. Shoot me, and I'll scream. The brain stem and amygdala will always do their job of struggling to preserve one's life at any cost." Ernest Becker has famously said: "the fear of death haunts the human animal like nothing else" (1973, p. xvii). If, as he implies, the fear of death is an evolutionarily ancient animal fear, then presumably it would always have provided an important last-ditch barrier to human suicide. In fact its existence ought to mean that the thought "I can kill myself" must usually be something of an empty boast.

I have to say I am skeptical – and not just because people do in fact kill themselves, sometimes almost casually. I think there is actually precious little other evidence that humans have a naturally evolved fear of death. I do not, of course, disagree with Miller that humans have hardwired fears that motivate them to avoid situations that could put them at risk of dying – pain, anoxia, and so on. They do instinctively recoil from pain, and thus will certainly do what they can to avoid a painful death. That is why, for example, many people when terminally ill will choose – if only they are allowed to – to be "put to sleep" rather than to endure the agonies of cancer. For the same reason those intent on suicide will take precautions to prevent instinctive fears from thwarting their attempt. A case in point is David Kelly, the scientist who exposed the British government's lies about Iraq's weapons of mass destruction. He took 29 tablets of the painkiller co-proxamol before he slit his wrists.

So, no question, people often fear *dying in pain*. As Woody Allen said, they do not want to be there when it happens. However, if and when death is inevitable, but likely to come easily, all the evidence suggests that people generally take it remarkably calmly. The German photographer Walter Schels has made photos of people in the terminal stages of illness, shortly before they died and the day after. The 26 sitters for these portraits were asked how they felt about dying. They had mixed emotions: sadness, relief, resignation. But not one of them showed fear. Annoyance was more like it. One of them, Klara, remarked: "I'd only just bought myself a new fridge-freezer. If I'd only known" (Schels & Lakotta, 2015, p. 106).

Ah, some theorists say, but the lack of overt fear is due to some form of *denial*. When humans contemplate death they do become scared momentarily, but then according to "Terror Management Theory" they immediately suppress it (Solomon, Greenberg, & Pyszczynski, 2015). Or they deny the truth of the facts that would otherwise cause them to be scared (Varki & Brower, 2013). But I believe there is a more straightforward explanation. This is that fear of death simply does not exist, as an evolved adaptation, in either humans or any other animals.

How could that be? Why wouldn't such a useful fear have evolved, especially once humans discovered death's fuller meaning? I suggest the answer is that the ancient fear system was simply blindsided by the discovery. There had never before been occasion to respond to any such nebulous concept as the "idea of death," and now it presented special difficulties. How was natural selection to get to grips with a hypothetical state of *not being*? True, there are lesser states of not-ness that humans have had no trouble adapting to. They can and do have a natural fear of not being fed, not being warm, not being loved. But not being at all, not existing? It must be just too elusive a concept.

This said, we should not assume that human suicide was destined to remain unopposed. If nature was unable to arrange things so that people instinctively feared dying by their own hands, then perhaps human culture could step in to arrange it. Or, as a completely different strategy, perhaps the threat of suicide could be answered by developing a newfound appetite for staying alive. I will consider in a moment how culture may indeed have weighed in to supplement biology.

But first, let us take a further look at the size of the problem our ancestors faced, for we have not yet revealed the full scale of it. At the critical juncture in prehistory, when the understanding of self-killing first surfaced, just how vulnerable would early humans have been? As far as I know, no palaeoanthropologist has ever thought to ask. But I would say we should assume the worst. To start with at least, people would have had no kind of immunity to suicidal thoughts. In which case it is realistic to imagine a scenario where suicide would have spread like measles in an unprotected population. And indeed measles is an alarmingly apposite analogy, because, as contemporary evidence shows, even today the suicide “meme” is highly infectious. It jumps all too easily from one mind to another.

As Durkheim noted: “Suicide is very contagious . . . There is the well-known story of the fifteen patients who hung themselves in swift succession in 1772 from the same hook in a dark passage of the hospital” (Durkheim, 1897/1951, p. 97). I suggested earlier that almost all suicides may be copy-cats. But suicide contagion is something more: copying with positive feedback. It has been dubbed the “Werther effect” after the hero of Goethe’s novel *The Sorrows of Young Werther*, who kills himself after falling hopelessly in love with a married woman (Phillips, 1974). Following its publication in 1774 there were hundreds of imitative deaths across Germany.

Recent research has confirmed just how strong the effect is (Gould, Kleinman, Lake, Forman, & Middle, 2014). Every time a celebrity suicide is given exposure in the newspapers or on TV, the copy-cats follow. It is estimated that Marilyn Monroe’s death in August 1962 was responsible for 200 extra suicides within a month. After a popular South Korean actress hung herself in 2008, suicides jumped 66% that month, with young hanging victims accounting for most of the increase (Hvistendahl, 2012).

But 66%, that is nothing. There are still parts of the world today where rates of suicide are ten times the average elsewhere, apparently as the result of local chain-reactions. MacDonald’s research among the generally contented people on the island of Palawan in the Philippines found evidence of waves of suicide spreading through small villages. In a recent study Jollant and MacDonald (2015) undertook a psychological autopsy of the individual victims to try to uncover predisposing factors. It turned out that the most significant risk factor was having had a close relative die from suicide. MacDonald (2003, p. 264) comments: “The child grows up accustomed to the idea. He/she sees or hears about elders, uncles, aunts, older cousins, and friends’ parents killing themselves . . . Thus suicide becomes an accepted model of behaviour, an option open to the individual.” Note how the thought “I can kill myself” can then take on an added meaning: “I can,” not only in the sense that it is practicable, but that it is permissible.

What can have happened on Palawan to get the chain reaction started? MacDonald believes suicide was at a “normal” level until early last century some kind of disaster struck – a cholera epidemic, a slave raid – that wrecked the villagers’ lives. This caused a surge in suicides, and the wave has been propagating ever since.

So, to ask it again, how prevalent might suicide have been among our ancestors? Suppose it is true that they first became at risk about 100,000 years ago. To begin with, the incidence might have remained relatively low. However, once humans left Africa, living conditions were set to become increasingly harsh. In the icy climate of central Europe 50,000 years ago, with people battling the elements and in murderous competition with their neighbors, there would have been plenty of occasion for short-term despair. If then the rate of suicide reached a critical level, it could have become epidemic. Who knows, but that suicide threatened the very survival of whole populations. There have been several genetic bottlenecks in human history, suggesting that populations crashed almost to nothing. These have been attributed to factors such as internecine strife, volcanic winter, or disease. But perhaps the real cause was this worm inside the human mind.

Still, here we all are today. Against the odds, our ancestors as a species evidently managed to pull through. Given that dedicated anti-suicide defenses were absent or slow to evolve, what else could have brought the epidemic under control? Presumably the best hope of developing timely and transferable defenses must have been human culture. Here, I have to say, the picture is complicated and not well-researched. But at least some of the more recent cultural barriers to suicide are in plain view (Barbagli & Byatt, 2015).

In historical times religious authorities have repeatedly issued anathemas against suicide. Medieval Christianity decreed it to be a mortal sin. Self-murderers would not be given decent burial, but rather be buried at a cross roads with a stake through the heart. In all modern states, until recently, suicide and attempted suicide have been considered to be crimes under the common law. The successful perpetrator’s possessions could be confiscated, and the unsuccessful one imprisoned. In some places the party supposed to have provoked the suicide – by spurning a love-suit, say – could also face a penalty. In the UK attempted suicide was not decriminalized until 1961. In the ten years pre-1961 nearly 6,000 people were prosecuted, of whom 5,400 were found guilty, and imprisoned or fined. It was common practice in the 1950s to have a policeman sitting at the bedside of an unconscious patient in Accident & Emergency waiting to interview them.

There have also been attempts to limit the spread of the suicide meme by limiting exposure to it. In Europe, after the effect of Goethe’s book became apparent, it was soon banned in several countries. In Germany it was even forbidden to dress like Young Werther in blue coat and yellow trousers. In most countries today, there are strict guidelines for the press, intended to play down the reporting of suicide – to keep it off the front page and avoid sensational headlines.

These are deliberate measures, with suicide directly in their sight. But there are also cultural practices that can work to deter suicide without targeting it so deliberately. One obvious and important way is by instilling beliefs that are incompatible

with the premise that can make suicide so appealing to someone who wants to escape: namely, the belief – the hope – that death will bring about mental oblivion. The world over humans have invented systems of religious belief that explicitly promulgate the idea of the *mind continuing after death*. What's more, the Abrahamic religions in particular make a point of threatening that the afterlife for sinners, and suicides especially, will be an unpleasant one.

Now, even though humans may not be set up by nature to fear the nothingness of death, they can quite easily be set up by culture to fear the somethingness of an afterlife. The threat of hell fire can certainly set the amygdala ringing. But it need not be so specific as fire. It could be just the threat of strangeness, the unknown. Think of Hamlet, contemplating suicide:

But that the dread of something after death,
The undiscover'd country from whose bourn
No traveller returns, puzzles the will
And makes us rather bear those ills we have
Than fly to others that we know not of.

I am not suggesting that the idea of a horrible afterlife was ever invented specifically to deter suicide. But if, as is surely the case, it has consistently worked to this effect, this is presumably a reason why it has taken such a hold. Some humans undoubtedly owe their lives to it.

It is evident how culture has found ways to weigh in against suicide on several levels. The measures are by and large negative ones. They are clearly not wholly effective. But there is no question they can and do work as a deterrent. The fact that suicide rates are lower in Muslim countries, for example, presumably has something to do with Muslim teachings about hell. As the exception that proves the rule, the villagers of Palawan are reported to have largely lost any faith in an afterlife (MacDonald, 2003).

But does deterrence have to be the only strategy? Wouldn't we expect more positive methods to have evolved as well? In place of punishment or censorship or threats, why not oppose a destructive mind virus with a redemptive one?

The English priest Chad Varah founded the Samaritans in 1954, a group dedicated to talking suicides down, simply with words of reassurance. The message "There is hope," posted on the bridge or beside the railway track, may seem to verge on the banal. But in fact this is the one message that human society might long ago have discovered it can give with confidence. Research shows that in nine cases out of ten the hurt is not going to last. Daniel Gilbert, author of the book *Stumbling on Happiness*, advises: "Few of us can accurately gauge how we will feel tomorrow or next week . . . We expect to feel devastated if our spouse leaves us or if we get passed over for a big promotion at work. But when things like that do happen, it's soon, 'She never was right for me,' or 'I actually need more free time for my family.' People . . . mistakenly expect such blows to be much more devastating than they turn out to be" (from Dreifus, 2008).

The lesson is simple: “Do not jump now, because it is not what your future self would choose.” Have humans had to wait for a Harvard psychologist to tell them this? Thankfully, not. The message is implicit – presumably for a good reason – in much of the hand-me-down wisdom of our folk cultures: the stories, songs, proverbs, and so on that are there to remind people if ever they doubt it that life is worth living after all.

What does make life worth living? The poet Byron wrote: “The great object of life is sensation, to feel that we exist even though in pain” (Woolley, 1999, p. 28). I suggested earlier that, in the course of history, suicide might have been countered by some newly evolved appetite for staying alive. For example, humans collectively might have come up with some knock-down philosophical argument to chase away Santayana’s skepticism. Maybe so, though we have yet to see it. But how much more promising, at the level of the individual, if natural selection acting on human genes could have found an answer internal to the self. Could mere – mere? – *sensory consciousness* have been refashioned in the course of human evolution just so as to make people pause before they seek oblivion?

“There’s night and day, brother, both sweet things; sun, moon, and stars, brother, all sweet things; there’s likewise the wind on the heath.” The words are from *Lavengro*, the autobiographical novel of the Victorian adventurer George Borrow. As Borrow tells it, he has been reading Goethe. He is toying with the idea of suicide. He gets into conversation with a Romany gypsy, Jasper, whom he has befriended on his travels. “What is your opinion of death?” says Borrow, as he sits down beside him. “Life is sweet, brother, who would wish to die?” “I would wish to die,” says Borrow. “You talk like a fool,” says Jasper. “Wish to die indeed! There’s the wind on the heath, brother; if I could only feel that, I would gladly live for ever” (1900, p. 180).

It strikes a deeply human chord. We *get* it. But stop to consider just how unexpected this is. How come these sweet things – “the sun, moon and stars,” “the wind on the heath” – can be reasons not to kill ourselves? How come we humans are so awestruck by sensory experience (Silva, 2013)?

The phenomenal quality of consciousness is widely regarded as a mystery. I have suggested in my book *Soul Dust* (Humphrey, 2011) that its very mysteriousness is an adaptive feature. The seemingly magical qualities of sensation – the redness of red, the saltiness of salt, the paininess of pain – have been specifically designed by natural selection to impress us with their inexplicable out-of-the-world properties. Human consciousness exists on this level, as a biological adaptation, precisely to “change the value we place on our own existence” (Humphrey, 2017).

I have been taken to task by critics for suggesting that any biologically evolved organism could need a “reason to live” over and above the imperatives of life itself. Yet human beings are not *any* organism. They are the first to have had to wonder whether it is all worthwhile. We have seen the dark side in this chapter. If there is a bright side to the lure of death, it may be that humans have come to live – perforce – in a strikingly beautiful world.

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FROM CORPSE TO SYMBOL

Proposed cognitive grades over
the long-term evolution of
hominin mortuary activity*Paul Pettitt***Introduction**

In 1907, the anthropologist Robert Hertz, in his celebrated *Contribution to the Study of the Collective Representation of Death*,¹ outlined the familiar elements of human mortuary activity, drawn from numerous small-scale, non-industrial groups for which ethnographic information was available to him at the time. At first sight these beliefs and behaviors seem immediately familiar to modern, urban humans, and may well be taken as features that distinguish our cognitively evolved species from the rest of the animal world. Drawing on cross-cultural observances, Hertz noted in particular the ubiquity of notions of a *soul* (i.e., some form of extrasomatic persistence of individual consciousness post-biological death); a *special language* that humans use to refer to death and its social effects, which is often distinct from quotidian language or draws on words otherwise rarely used; the concept of *another world* that we cannot see or do not experience directly but which the spirits of the dead are thought to inhabit or travel to or through; *forefathers* (ancestors) who still exercise social agency among the living despite being biologically dead; an emotional *care* and corresponding concerns for the *correct funerary treatment* of the dead; *obligations* of a *moral* nature to the dead, which require and define *specific actions* that link the living to the dead in specifically prescribed ways; and *special duties* that modify the usual patterns of group life by the addition of formal responses to death that are held for *certain periods*. All of these pertain to a *collective representation* of death in Hertz's phrase; that is, the full social participation of the social group in the marking of deaths and their effects.

But which of these elements of collective representation might be held to be truly distinctive of humans; which might be said to be fully "symbolic" in nature, that concept of "behavioral modernity" beloved of palaeoanthropologists researching

the biological and behavioral origins of *Homo sapiens*? There can be no doubt that several of these must have a symbolic underpinning, given that they refer to and express shared concepts about the departed among the living. In Hertz's specific examples, concepts of the persistence of the dead, the imaginary worlds that they inhabit, and their continuing agency among the living straddle both the real and imaginary worlds, and reflect the perpetuation of complex cosmological beliefs mediated through society and its social agents. This must reflect a cognitive capacity for symbolic thought.

The archaeological record pertaining to human mortuary activity should allow us to evaluate exactly when and how the dead came to be embodied in such fully symbolic systems, and perhaps how this broadly relates to human cognitive and social evolution. If we can identify when corpses were deliberately moved away from the living, or deposited in specific places, then palaeoanthropology may be able to provide a bridge between the chemical and cultural stimulants for dealing with the dead (Pettitt, 2018). But it will do us archaeologists no good simply to define mortuary activity as being *either* symbolic or not. There are gradations to the complexity of cognitive foundations of mortuary behavior (Pettitt, 2011b), and no a priori reason why an otherwise "animal-like" behavior at some recent point suddenly became "modern" when groups began putting their dead under the ground.

I have previously taken a holistic approach to the evolution of hominin mortuary activity (Pettitt, 2011a, 2015, 2018), using zoological (including primatological) and anthropological perspectives as heuristics for the long-term development of human treatment of the dead. Archaeologists have often regarded burial as either the developmental summit of human mortuary activity or its first manifestation. It is an odd behavior – digging shallow graves and sticking the dead in them – and for small groups of mobile hunter-gatherers represents a costly activity in both time and space, when other means of abandonment and disposal may serve just as well. In this sense at least burial does indeed represent a significant behavioral innovation; it appears to separate at least two hominin taxa – Neanderthals and modern humans – from their hominin predecessors who apparently did not bury their dead, as well as from their contemporaries in the animal world. Although most palaeo-anthropologists would agree that we have 20 to 30 convincing examples of Middle Palaeolithic burials, these are so relatively few that we cannot justify the conclusion that "all Neanderthals buried their dead"; rather, it may be more productive to ask why some Neanderthals buried some of their dead some of the time. The same rarity can be observed for burials of Upper Palaeolithic European *Homo sapiens*, even if one might here identify the first unambiguous indications of a wider cognitive and cultural context for such behaviors. At its simplest, the act of burial can be non-symbolic; but at its other extreme it can constitute a symbol, involving a complex interplay between both living and dead. But how, for example, does placing a corpse in a shallow grave *really* differ in its cognitive underpinning from a female chimpanzee carrying around the body of her dead child for several days or months (e.g., Goodall, 1986; Matsuzawa, 2003)? Why should the inclusion of simple grave goods such as a piece of worked flint or animal bone in a grave – all we have in a very few

examples prior to the Mid Upper Palaeolithic – necessarily reflect symbolic behavior, even if it can be assumed to have been deposited deliberately? As with personal ornamentation, there is no reason why the treatment of the dead could not have differed in the scale, nature, and complexity of symbolic function over the course of hominin evolution, and it serves no purpose to make overarching generalizations.

In order to problematize the development of human treatment of the dead we need to start from a more specific terminology. I therefore distinguish between *mortuary* activity, which is a broad concept, describing anything relating to death and to the treatment of the dead, and, by contrast, *funerary* activity, a far more specific set of behaviors relating to the deliberate disposal of the dead and to their subsequent commemoration (Pettitt, 2018). From observations in the primate world we might predict that examples of the former were variably practiced by early hominoids and hominins: This might include the examination of corpses for signs of life, which I have defined as *morbidity* (Pettitt, 2011a); expressions of frustration and anger such as pummeling the corpse; examples of cannibalism; and curation of the dead over the process of emotional detachment from it. Funerary behavior presumably arose out of a variable suite of mortuary behaviors when artificial forms of disposal (graves) or material aids to remembrance/commemoration (e.g., grave markers and formal cemeteries) began to order the treatment of the dead in socially prescribed ways.

Deep roots: the early evolutionary development of hominoid and hominin mortuary behavior

Treatment of the dead in the animal kingdom as a whole might be said to have evolved as a process of accumulation through four main stages: chemical, emotional, rational, and, in the case of humans at least, cultural (Anderson, Biro, & Pettitt, 2018; Pettitt, 2018). Diverse animal taxa from insects upward remove carcasses from living hives in order to minimize risk of contagion in a chemically driven process, the extent of which should not be underestimated (López-Riquelme & Fanjul-Moles, 2013; Sun & Zhou, 2013; Yao et al., 2009). We might, therefore, expect that hominins inherited from their deep evolutionary past a revulsion toward the corpses of their conspecifics; a concern with blood; and probably an ability to identify places in the landscape where conspecifics died (Pettitt, 2018). The simplest way to deal with corpses is either by removing them from proximity to the living or by covering them up, practices that among nonhuman animals have been termed *necrophoresis* and *necroclaustralization* respectively (Chouvenec, Robert, Sémon, & Bordereau, 2011; López-Riquelme & Fanjul-Moles, 2013; Sun & Zhou, 2013; Wilson, Durlach, & Roth, 1958).

Only in recent times have humans become isolated from a frequent and visceral experience of death of close conspecifics. By contrast to modern industrialized societies, hunter-gatherers routinely deal in death, which is for them “a way of life” (Woodburn, 1994). The overwhelming emotions that are evoked by death are structured between the poles of anger (the expression of frustration, confusion, etc.) and grief (sorrow, loss, etc.), and although we may never hope to ascertain the specific

emotions that underpinned archaeologically visible expressions of mortuary behavior, we may at least assume that some complex interplay of emotions – particularly centered around these poles of sorrow and anger – formed part of the very partial remains of mortuary behavior that comes down to us in the form of fear, grief, and aggression (Pettitt, 2018).

Following this, processes of rationalization include attempts to understand the cause of death; to mitigate for the emotional and social disruptions it causes; and ultimately to anticipate, explain, and perhaps try to prevent it (Pettitt, 2018). Rationalization transforms the chemically and emotionally driven mortuary behaviors into socially repeated and, ultimately, rule-bound cultural activities. It may, therefore, provide a mechanism for how the complexity of otherwise face-to-face and transient mortuary behaviors came to be embedded in the landscape at specific places, which was arguably the most important mortuary transition in hominin evolution (Pettitt, 2015). Cognitively, one might reasonably expect mortuary activity to have been among the package of social activities under selection to evolve as group size and social complexity grew (Aiello & Dunbar, 1993; Dunbar, 2003; Gamble, 2010). As most human belief systems strongly deny that death is an individual extinction (Bloch & Parry, 1994), we might expect rationalization activities to involve an active anticipation of death and attempts to stave it off (Kellehear, 2007), strategies that can be understood as *strategies against death* (Davies, 2017).

Elsewhere, I have tried to outline a picture of the long-term development of mortuary activity in its widest sense, beginning with the existing archaeological record (Pettitt, 2011a). The record is patchy to say the least, and what we recognize as mortuary activity in the archaeological record may not only reflect a small part of an otherwise archaeologically invisible behavioral repertoire, but also reflect only those aspects of behavior that were in some way responses to exceptional rather than quotidian events, such as unexpected or violent deaths (Pettitt, 2018). As with other aspects of hominin behavior, there is no reason to believe that mortuary activity evolved in a linear fashion, and the cumulative nature of its development and increasing regional variability noticeable over time suggest that it certainly did not. In Europe, however, the data are robust enough to allow a degree of interpretation, some of the most pertinent of which I present in Table 27.1.

In brief, the long-term evolution of hominin mortuary activity that I propose began with an emotional and intellectual interest in the corpse (*morbidity*), the consumption of body parts under certain social conditions, and attempts to curate or cover the corpse in non-symbolic contexts. All of these can be observed among extant primates (Pettitt, 2011a and references therein). At some point – possibly within Pliocene australopithecine or early *Homo* groups growing in size and/or social complexity – these core responses to death became elaborated, mainly through the deliberate deposition of the dead at certain parts of the natural landscape (*structured deposition*), creating a conceptual link between the dead and the landscape. Eventually, enclosed features of the natural landscape, specifically caves and fissures,

Table 27.1 Evidence and potential evidence of mortuary activity among European premodern hominins, presented by body or place focus, and arranged chronologically. For inhumation, only sites with multiple burials are included, as with single (i.e., isolated) inhumations one cannot rule out a fortuitous connection with specific places.

Chronology	Body focused	Place focused	Body and place focused
~800–850,000 ybp	Gran Dolina, Atapuerca (Spain), TD6 Aurora stratum, <i>Homo antecessor</i> : removal of soft tissue on cranial and postcranial remains of several individuals		
~400–500,000 ybp		Sima de los Huesos, Atapuerca (Spain), <i>Homo heidelbergensis</i> : possibly deliberate deposition of at least 28 individuals near shaft (cut marks on teeth appear to pertain to paramasticatory use of the dentition, not to defleshing)	
~300–340,000 ybp	Castel di Guido, near Rome (Italy), archaic hominin with <i>H. erectus</i> and <i>H. neanderthalensis</i> features: defleshing of the cranium		
~120–140,000 ybp	Krapina (Croatia), <i>Homo neanderthalensis</i> : defleshing of several individuals including scoring of forehead of Krapina 3		
~100–120,000 ybp	Moula Guercy Cave level XV (France), <i>Homo neanderthalensis</i> : defleshing and disarticulation of six individuals for nutritional cannibalism		

Probably ~60–75,000 ybp

La Ferrassie (France), *Homo neanderthalensis*: deposition of seven individuals in excavated graves/pits, and defleshing of cranium of La Ferrassie 6; possible use of stone slabs as markers

~60–70,000 ybp on chronocultural grounds (MIS4)?	Combe Grenal (France), <i>Homo neanderthalensis</i> : defleshing	
~60–70,000 ybp on chronocultural grounds (MIS4)?	Marillac (France), <i>Homo neanderthalensis</i> : defleshing	
~40–50,000 ybp		Shkafi Mazin Shanidar (Iraq), <i>Homo neanderthalensis</i> : burial of at least four individuals (possibly more), these four in apparent spatial association
~40–43,000 ybp		Sima de las Palomas (Spain), <i>Homo neanderthalensis</i> : deliberate introduction of at least three individuals into cave
~41–42,000 ybp		Feldhofer Grotte, Neanderthal burial
~37–41,000 ybp		El Sidrón (Spain), <i>Homo neanderthalensis</i> : deposition outside the cave and defleshing and disarticulation of at least eight individuals

Source: From Pettitt (2015) and references therein.

became repeatedly used for such *funerary caching* – the deliberate deposition of corpses in these nooks and crannies, at least by Neanderthals and early *Homo sapiens*.

By ~100,000 ybp (years before present) these hominins occasionally took the next logical step, deliberately *creating* such caches for burial (simple “graves”), and on occasion imbuing certain locales with specific mortuary meaning and depositing several corpses at *places of multiple burial* such as La Ferrassie (France) and Shanidar (Iraq) Caves in the case of Neanderthals, and Skhül and Qafzeh Caves in Israel for early *Homo sapiens*. As the archaeological record currently stands, it was only with the Old World dispersal of *Homo sapiens* <55,000 ybp that further innovations appeared – notably the circulation of human remains as personal ornamentation and relics from the European Early Upper Palaeolithic onward, and richly accompanied formal burials of *some individuals* in the European Mid Upper Palaeolithic (~31,000–22,000 cal ybp). One might infer from this that *commemoration* – the active and materially assisted remembrance of individuals – was practiced at least from this time, and thus that by the time of the Early Upper Palaeolithic, human individuals both living and dead had become incorporated into cosmological belief systems. Such patterns are found in the Late Upper Palaeolithic (at least between ~19,000 and 13,000 cal ybp), by which time the two extreme expressions of mortuary activity – fragmentation (of the body) and collection (of many bodies into formal cemeteries set aside from the living) – appeared. I have previously divided this development into five broad stages (Pettitt, 2011a), and develop this further here, as summarized in Table 27.2.

Several scales of change can be observed in this development. Pre-mammalian, pre-hominoid, and core hominoid mortuary activities occurred face-to-face, in the here and now, reflecting a temporary behavioral operationalization of the chemical, emotional, and, perhaps, early rational responses to death, morbidity, and the resulting social theater. There is no reason to assume that any of these behaviors need have a duration of more than a single day, and they were probably limited by the group’s need to move on and return to their foraging round. This may have sufficed for the small groups typical of hominoids and early hominins, but growing social group size and complexity, however, may have rendered such expedient and non-material mortuary behaviors as increasingly difficult to sustain. For this reason, I have suggested that the use of the landscape as a rudimentary mechanism of commemoration, specifically through the association of places with the dead, could have increasingly taken over as a means to prolong mortuary activities, at least when groups could return to these locales (Pettitt, 2015). This would result in a degree of expansion of core behaviors that heralded the *archaic* mortuary phase, in which the caching of bodies at recognized points of the landscape brings new (albeit modest) spatial and, possibly, temporal scales into the mortuary process. Although early activity in this phase, such as the deliberate deposition of several corpses in long grass by *Australopithecus afarensis* that I have suggested lies behind the accumulation of Afar Locality (AL) site 333 (Pettitt, 2011a), still reflects very brief periods of time, later expressions such as the funerary caching of at least 28 individuals of *Homo heidelbergensis* at the Sima de los Huesos at Atapuerca, Spain, imply somewhat stronger conceptions of a

Table 27.2 Proposed grades of hominin mortuary activity.

<i>Grade</i>	<i>Proposed development</i>	<i>Manifestations</i>
Pre-mammalian	Insects	<i>Chemical stimuli</i> <ul style="list-style-type: none"> • Necrophoresis and necroclaustralization • Identification of places of death and danger
Pre-hominoid	Birds, mammals	<i>Emotional stimuli</i> <ul style="list-style-type: none"> • Social theater around corpses • Specific death-related calls
Core hominoid	Miocene and Pliocene hominoids (Pliocene hominins onward)	<i>Rationalization</i> <ul style="list-style-type: none"> • Infanticide and cannibalism (emotional) • Socially mediated morbidity of the corpse • Manifestations of mourning expression, including depression, calls, and curation of corpses as acts of detachment • Social theater around corpses; controlled access to corpses; use of corpses as adjuncts to display (mortuary gatherings)
Archaic hominin	Australopithecines, early <i>Homo</i> and, archaic <i>Homo</i> to the origins of <i>Homo sapiens</i>	<i>Rationalization and possible cultural elaboration</i> <ul style="list-style-type: none"> • Elaboration of cannibalism, morbidity, and mourning • Use of specific places for funerary caching
Modernizing	<i>Homo (sapiens)</i> <i>neanderthalensis</i> and <i>Homo (sapiens) sapiens</i>	<i>Culturalization of mortuary activity</i> <ul style="list-style-type: none"> • Continuation and elaboration of the aforementioned • Repeated use of places in the landscape for disposal of the dead and some marking of the positions of the dead (cemeteries <i>sensu stricto</i>) • Possible use of material culture as adjuncts to burial
Modern	<i>Homo sapiens</i> (European Mid Upper Palaeolithic onward)	<i>Culturalization of mortuary activity</i> <ul style="list-style-type: none"> • Continuation and elaboration of the aforementioned • Repeated deposition of the dead in cemeteries, set aside from the space of the living, usually with marking (commemoration) of the dead • Elaboration of types of burial (single, double, triple, multiple) • Inclusion of grave goods • Association of new phenomena with burial (e.g., fire, art) • Elaborate rules underlying burial as a form of containment • Recognition of the status of the dead in burial or other funerary activity • Evidence for continent-wide cultural traditions of burial practice

Source: Developed further from Pettitt (2011a) and (2018).

place of the dead, although it should be noted that other, non-mortuary, explanatory hypotheses exist for this (Zilhão, 2015). The increasing variability of practice observable in the *modernizing* phase – which saw the rise of formal burial *sometimes* – must indicate that specific concepts about the dead and how they should be treated by the living existed, at least in some human groups, from the Middle Palaeolithic and/or the Early Upper Palaeolithic onward. Why otherwise would Neanderthals and early *Homo sapiens* artificially create graves to inter their dead, when numerous niches, fissures, caves, and rock shelters provided ample opportunity for funerary caching?

If the necroclaustralization of the body for reasons of hygiene, distaste, health, or safety were the sole reason for early burial, one might expect it to have been practiced more frequently and in more geographical regions where late archaic and early modern humans were operating. But it was not; its distribution is remarkably patchy in space and time, and this cannot be explained simply by taphonomic arguments. When such patchy expressions of other behaviors are found in the Palaeolithic (and for that matter primatological) record they are interpreted as a reflection of cultural variation. That the earliest burials are already associated with a degree of materiality such as rare grave goods, other use, and even “architectural” adjuncts to graves such as the stone markers at La Ferrassie or the “tombs” of Regourdou (Table 27.1) further indicates, in my opinion, that mortuary activity during the archaic and modernizing phases was at least in part stimulated by reasons beyond the prosaic. Clearly, some individuals were recognized as requiring burial for whatever reason, whereas most were not. Although there are no convincing indications of differing social status among Neanderthals, it may be that a distinction was made between those individuals who should be accorded burial at death and those who should not. Whether or not this arose from social distinctions in life, or from the manner of their deaths, cannot be answered as yet, but at the very least this indicates that some individuals were specifically associated with a particular (and new) form of mortuary activity. Thus a connection was made between the social persona of the deceased and the act of burial. This need not have been fully symbolic in the sense that archaeologists usually assume for the term, although it is easy to see how the increasing elaboration of such “connections” between social persona and mortuary practice could eventually result in symbolically mediated detachment rituals.

Mortuary practice and symbolic systems

Symbolism or a “symbolic capacity” has come to be seen as a major defining characteristic of *Homo sapiens* (e.g., Bar-Yosef, 2002, p. 378; Henshilwood & d’Errico, 2009; Henshilwood & Marean, 2003; Hovers, Ilani, Bar-Yosef, & Vendermeersch, 2003). In all modern human groups cultural behavior is mediated by symbolism (Chase & Dibble, 1987), and Henshilwood and Marean (2003) define “modern behavior” as that which is organized symbolically. Wadley (2001) suggests that one may only infer “full” symbolism from the archaeological record if it displays unambiguous evidence for external storage of information. Clear evidence for pigment transport and use by Neanderthals at least as early as 115,000 ybp (d’Errico, 2003; Hoffmann,

Angelucci, Villaverde, Zapata, & Zilhão, 2018b) and for their creation of nonfigurative cave art by at least 65,000 ybp (Hoffmann et al., 2018a) demonstrates that they too must be seen in the same light. At what point in its evolutionary development may mortuary activity be said to have been structured symbolically? Although as noted earlier, degrees of “symbolism” are likely to have been both variable and complex, some simple cognitive grades may underlie the behavioral expression of mortuary activity:

- *Simple (non-symbolic) observation*: Little activity occurs beyond expressions of emotion, morbidity, and social theater at funerary gatherings. Cognitively this could amount to little more than the concept “it is dead; I am confused” and attempts to understand why the corpse is no longer animated.
- *Emotive (non-symbolic) interaction*: The living now begin to engage further with the dead, and their emotional response affects (i.e., determines) certain simple behaviors of disposal. “It is dead; I am mourning; hide the corpse away as it is distasteful.” At this stage, however, calls and gestures can be used to signify the emotional poles of anger and sorrow.
- *Passive associative (non-symbolic or symbolic) interaction*: At a rationalizing level, the dead are now associated with a *specific activity* at a *specific place*, and this place is used to remember (commemorate) the dead; i.e., it *symbolizes the dead*. Associations are now made between the dead, the landscape, and the living social group. “He is dead; he must be disposed of at a recognized place.” That place, however, need not be artificially modified; no energy need be invested in a place; bodies are simply deposited there.
- *Active associative (symbolic) interaction*: As in the passive stage, but energy is now invested in the place of disposal; i.e., natural features are widened, graves are excavated, and adjuncts such as grave goods, stone coverings, and other use may occur from time to time. The deliberate modification of such locales suggests that specific meaning was attached to them, perhaps as an element in a wider set of social beliefs.
- *Time-/space-factored associative interaction*: The agency of the dead is now recognized in mortuary treatment (who gets special treatment, where and when), and mortuary activity is organized in time and space according to social rules. “He is dead; he was an elder in life and has earned the right to be buried at the place of the elders.”

One cannot simply argue that even archaeologically observable mortuary activity was “symbolic” in any straightforward way; arguments that “grave goods” are always symbolic do not problematize what we mean by symbolism, and as a result get us nowhere. Scholars would probably agree that Mid Upper Palaeolithic mortuary activity had a strong symbolic character given its widespread shared characteristics (ocher, inclusions such as personal ornamentation, association with bones of large herbivores), regional variations among these, repetitive patterns, “non normal” subjects (pathological individuals and violent deaths), and associations with objects

clearly of a symbolic nature. It is probably fair to assume that fully time-/space-factored associative symbolism was in operation by this time and characterizes at least the modernizing and modern (and perhaps a little of the archaic) mortuary phases.

Neanderthal and earliest *Homo sapiens* mortuary behaviors may have been structured according to active associative interactions with the dead; the variability of mortuary activity visible in the European Middle Palaeolithic and at Skhül and Qafzeh Caves in Israel as well as the rare examples of elaborate behavior such as for European Neanderthals at Regourdou and La Ferrassie suggest clearly that by at least 110,000 ybp the dead could be associated with specific places and specific behaviors, and that distinct, albeit short-lived, traditions of these associations arose from time to time. It is interesting in this light that there are no definable differences between modernizing period burials of the Neanderthals and early modern humans, and in terms of their burials “we see no clear-cut indications that anatomically modern humans were culturally ‘more advanced’ than Neanderthals” (d’Errico, 2003, p. 196). One might only draw this distinction from the Early Upper Palaeolithic onward (on the basis of human relics) or the Mid Upper Palaeolithic (on the basis of grave goods). The appearance of burials at this time may have wider cognitive importance. As d’Errico et al. (2003, p. 26) have suggested, “it is difficult to imagine that a human group could excavate a grave, position the corpse in the pit, and offer funerary goods with no form of verbal exchange.”

I have defined burial as a process of *at least three stages*: the excavation of a grave, placement of the corpse within it, and subsequent covering of the corpse (Pettitt, 2011a). This is an organized (and in many cases, I suggest, difficult) behavior, and I agree with d’Errico et al. that the practice could not have spread within and between groups without the communication of its basic concepts, not least of which would be digging through difficult sediments with small lithic or organic tools. Some burials – of the Neanderthals in particular – reveal longer mortuary *chaînes opératoires*: It is difficult to see how the several distinct burials of La Ferrassie could have been emplaced without a degree of planning, at least for its groups of infants buried in pits, and it is, I suggest, *impossible* that the mortuary ensemble at Le Regourdou could have been constructed without an underlying and elaborate set of beliefs. If it is correct that the corpse of a brown bear and that of a Neanderthal were deliberately buried here effectively side-to-side in this cave, then this *must* invoke a deliberate conceptual association of the two.

In this light, a sharp cognitive distinction can be made between the act of burial – which is predicated upon the communication of a set of ideas about a *chaîne opératoire* of three or more stages – and funerary caching, which need not require complex communication. Funerary caching could be achieved simply by doing it, demonstrating that a corpse can be hidden away. If I am correct that formal burial arose out of funerary caching, originally as the modification of natural caches and latterly as the deliberate construction of them (both occur in Skhül and Qafzeh), then the new innovation, which facilitated the development of specifically *funerary* behaviors, could have been underpinned by the complex language that its innovation and spread required as its cognitive basis. While one may or may not be justified

in calling this “fully symbolic” it certainly represents a major step toward it; and to those colleagues for whom “symbolism” is a black and white issue, the answer to the question “did Neanderthals possess a symbolic capacity?” must, simply, be yes.

In the modern world, symbolic constructions underpin all mortuary and funerary activities, no matter the nature of the communities indulging in them. I have argued earlier that “breaking down” the data into a set of cumulatively complex grades provides heuristics for approaching the archaeological mortuary record. From this it can certainly be said that mortuary activity was fully symbolically structured from ~31,000 ybp, possibly beforehand, and that a degree of symbolic underpinning is evident in Middle Palaeolithic burial back to ~100,000 ybp. By way of conclusions pertinent to the cognitive implications of hominin mortuary activity, a small set of working suggestions can be forwarded.

- Only from the last few thousand years of the Pleistocene (i.e., from ~15,000 cal ybp) did what we recognize as “normal” ways of disposing of the dead originate. As a number of specialists have suggested these probably arose out of rising population size and increasing semi-sedentism (and hence, territorial concepts), which eventually formed the cognitive basis of “agricultural” thinking. In the funerary sense this resulted, in some places and times, in formal cemeteries. As cereals and legumes came to be planted in the ground in specific areas, so were the dead, and both quickly came to symbolize claims to land through labor and ancestors.
- Before this – by the Late Upper Palaeolithic – funerary activity functioned as part of the wider symbolic realm, including the use in many contexts of figurative and nonfigurative art. A trend toward the increasing fragmentation (i.e., defleshing and processing) of the body and the curation of body parts is observable. This processing of the corpse parallels similar use of art and personal ornamentation, and *must* indicate that mortuary ritual at the time was embedded in widespread cultural beliefs.
- By the Mid Upper Palaeolithic, an increasing social differentiation between individuals (whether or not this was due to specialization, rank, or inherited status) was increasingly reflected by whether or not individuals were buried in the first place and by the nature of the burials that have come down to us. Complex interactions between the living and the dead correspond to widespread, probably continent-wide, traditions, superimposing regional traditions on these.
- By the Early Upper Palaeolithic, the relics of the dead were in circulation among living groups. Despite the lack of burials outside of Africa during this period, this suggests that symbolic interactions with the dead had come about by this time. Human remains pierced for suspension or deposited in elaborately equipped graves *must* indicate the commemoration of the dead.
- Among the Neanderthals and early modern humans, associative interaction with the dead is evident, at least in some places and in some periods. The active association probably required a degree of symbolism, at least in its more complex organization, although it remains to be seen whether this was fully symbolic.

- The association of the dead with specific places in the landscape has an antiquity stretching back at least to the Middle Pleistocene and to archaic *Homo*. It is the first archaeologically recognizable cultural association of the dead.
- Before this one might expect variable expressions of core mortuary activities back into the Miocene. One should expect these to have varied culturally, as other behaviors vary among modern chimpanzee groups.

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Note

- 1 To use the title of the 1960 English translation.

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AFTERWORD

Psychology and archaeology – the
past's long reach

Matt J. Rossano, Tracy B. Henley, and Edward P. Kardas

History matters. Nothing can be fully understood without an appreciation of its past. From where did it arise? To what blistering caldron or lighthearted musing can we trace its origins? History seems self-evidently relevant in the formation of individual psyches. What was it that made Dimitri an intemperate sensualist, his brother Ivan a tortured intellectual, while the youngest, Alyosha, grew into a pious, compassionate Christian? Forcing subtle variants in Karamazov DNA to bear the entire explanatory burden for these personality differences is untenable. Instead (and we would venture to guess that Dostoevsky would noddingly approve) it must have been how that DNA responded to and was molded by the life experiences of each brother – most notably their relationship (or lack thereof) with their father, Fyodor. To understand the individual psyche, one must unravel ontogenetic history. Psychologists (and novelists) have acknowledged this fact for a long time.

But ontogenetic history is not the entire story. Individuals are embedded within a particular cultural history. That history plays its own role in shaping the individual psyche. In the late 1960s and early 1970s, the Soviet Union embarked on an ambitious program of public and private socialist ritual practice (Lane, 1981). Public socialist holidays were introduced to replace or refashion traditional, religious ones. Similarly, private socialist-themed life cycle rituals marking birth, adulthood, marriage, and death were unveiled as substitutes for “archaic” existing ones. Government elites deemed the program essential for instilling a strong sense of Soviet identity and commitment to Marxist/Leninist ideals in the rising post-war generation.

That such a program was thought necessary had everything to do with generational history. The first generation in Soviet history without a direct memory of the Revolution or the Great Patriotic War (World War II) that saved the Revolution was coming-of-age. Past generations did not need socialist rituals to cement their commitment to the Motherland – struggle and suffering sufficed. But this new generation was restive. While the Soviet economy stagnated, they watched the West

grow increasingly prosperous, and they wanted their share. Many factors conspired to bring down the old Soviet Union, ascribing it solely or even primarily to the particulars of the post-war mind is naïve. But it was a factor; and it was not father-son (parent-child) relationships that made the post-war mentality susceptible to radical change. It was the socio-cultural context within which that mind was embedded. To understand the human psyche, one must also appreciate the cultural factors within which individuals operate. Sociologists and historians have acknowledged this fact for a long time.

The present volume is premised on the notion that even ontogenetic and cultural histories fall short in fully explaining the human psyche. Phylogenetic history must be added to the list; otherwise one fails to explain the peculiar potency that ontogenetic and cultural factors have in the shaping of the human mind as opposed to that of other animals. Chimpanzees certainly possess variant personalities (Maestripieri, 2005). But father-son relationships play no part in explaining those differences because, quite simply, *they do not exist*. Why not? The answer is rather simple – because chimpanzees, despite being our closest relatives, are a different species with a different evolutionary history. Natural selection made it so that chimpanzee sons and daughters do not have much to do with their fathers. Not so with humans, where paternal investment proved critical. The same can be said about generational/cultural factors. Chimpanzees have culture, but the culture of the chimpanzee youngsters growing up at this very moment in Tanzania is pretty much the same as what existed thousands of years ago. Nothing remotely similar can be said about humans. To fully understand the human psyche, it is not enough to ask “why are we the way we are?” We must further ask (as this volume attempts in part to do) “why aren’t we like other primates?” That question requires delving into phylogenetic history.

So why aren’t we like other primates? A recurring theme among the chapters in this volume is that humans are a more cooperative form of primate. That alone is rather remarkable given that primates as a whole are highly social. Humans appear to have taken sociality to an extreme. Many of the chapters provide background into the specific traits or mechanisms underpinning that extreme cooperativeness.

From tools to norms

A repeated theme in this volume is the importance of norms in the evolution of our hyper-cooperativeness. We are the normative primate. Part of our evolved psychology is a predisposition to believe that certain cooperative “rules” ought to be followed when interacting with others. But how does one set about studying the evolution of norms? **Konner** provides a general algorithm for attacking evolutionary questions, starting with the generation of hypotheses derived from studies of extant hunter-gatherers that can then be tested against archaeological remains. Bones and tools, he points out, can reveal quite a bit about our ancestors’ diets and lifestyles (e.g., hunting/gathering practices). They can also tell us about norms.

Oldowan tools are typically not considered a major cognitive step from the tool-making of nonhuman primates. In support of this, **Wynn and Coolidge’s** analysis

of the technical cognition required to create Oldowan tools reveals only modest differences between them and the toolmaking of chimpanzees. But those differences become more impressive when Acheulean handaxe construction is used as the point of comparison. In separate chapters, **Hodgson** and **Shipton** discuss two aspects of these tools (especially later versions of them dated roughly from 700,000 to 300,000 ybp) that appear to mark important advances in cognition – symmetry and regional variability. Many of these tools are far more symmetrical and aesthetically pleasing than necessary for practical purposes. The enlarged hominin brain (especially the visual pathways and their interconnections with the frontal lobe – as discussed by **Hodgson**) appreciated beauty and sought to reproduce it in tools. But the specific form that beauty took varied from one place to another. **Shipton** argues that these largely non-functional differences in both the finished product and the specific procedures for realizing it would have resulted from normative standards in gestural procedures. Put simply, Group A makes a particular variant of a handaxe using a certain procedure, while Group B makes a slightly different variant using a slightly different procedure. The reason for the difference is purely arbitrary – just traditional differences passed down generational lines. That said, **Burghardt** would surely entertain the possibility that these variants could have emerged from play.

Handaxe making traditions may have been some of the first (maybe *the* first) arbitrary normative standards that served as a group identifier. **Nielsen** sees something even deeper taking root here: the primordial shoots from which science and religion will eventually bud – science, from the cause-effect cognition of toolmaking; religion, from the social/normative cognition necessary for the transmission of toolmaking skill.

However, if norms start with handaxe making, **Sterelny** cautions that these early norms were likely implicit ones, not explicit. This distinction may be pivotal, and one that will likely undergo increasingly precise articulation as research progresses. At this point (as we understand it), the distinction turns importantly on self-monitoring: absent for implicit norms, present for explicit ones. Implicit norms are largely sustained through social reactivity. People conform or cooperate in order to avoid immediate punishments from other group members. These punishments could range from a master toolmaker's disapproving scowl cast at a novice using an "incorrect" procedure to weapon-wielding fellow hunters threatening bodily harm on someone attempting to dominate a kill. Even more furious reactions might be obtained where sexual impropriety is involved, as **Taylor** would likely agree. Even prior to these scenarios, **Twomey** might contend that a freeloader failing to do his or her part in keeping a fire alight would suffer natural negative consequences (e.g., freezing cold) even in the absence of social sanctions. Implicit norms guide our behavior so as to avoid punishment. But they lay the groundwork for the emergence of the self-monitoring capacity needed for explicit norms.

It may be at this point that **Gabora and Smith's** insight concerning the evolution of self-triggered recall becomes relevant. Learning to execute the approved cultural gestures for handaxe making is significantly facilitated by imitative skills. Chimpanzees are poor imitators. For them, the only "right" way of doing something is that

which produces the desired end. Not so with humans. As **Nielsen** discusses, humans are not just proficient imitators; we are overimitators – imitating even those aspects of a gestural routine that have no causal relation to the desired end. From where does this imitative expertise arise? A necessary mental prerequisite of imitative expertise may be the self-triggering capacity proposed by **Gabora and Smith**. Self-triggering recall would give one the ability to willfully call to mind the “correct” gestural procedure for performing some task and rehearse it, in order to refine and perfect it.

Two aspects of this ability are significant: (1) From the get-go, it is inextricably intertwined with social cognition. As **Nielsen** shows, overimitation is important socially, not technically. And: (2) Practice leads to automatization. As **Wynn and Coolidge** discuss, expert cognition is largely procedural, non-declarative, Type 1 knowledge. Conscious, Type 2 resources are freed up as expertise increases. This freeing up of cognitive resources produces what **Hodgson** calls “surplus cognitive capacity.” This capacity can turn outward to appreciate the beauty of symmetry and the meaning of visual patterns. But might it not also be turned inward to appreciate the beauty of “proper” gestural execution? As **Sterelny** argues, the technical bridges naturally into the social. The action itself is a technical procedure, but the feeling associated with it is engrained through social approval or disapproval. Once internalized, this feeling becomes a matter of personal pride. “Doing it right” makes one feel good about themselves. Pride and shame may result from expert cognition implemented in an expanded brain. This self-monitoring leads to explicit norms that generalize far beyond toolmaking or food-sharing. These norms govern nearly all aspects of social life and tribal identity (cooking, dressing, mating, hunting, or dancing) that are embodied, celebrated, and transmitted ritually.

From norms to rituals

Michael Tomasello (2014) has argued that norms (most likely explicit norms) arose as a result of group competition. As hominin groups increasingly came in contact with one another, better organized groups (meaning those with members more intensely committed to cooperative norms) wielded a competitive advantage. This selected both for within-group cooperative norms and for mechanisms (rituals) that firmly committed group members to those norms. Put simply, the groups with the best rituals (ones that most effectively committed members to group values) won. It was partly this line of reasoning that led **Rossano** to argue that ritual made us human. But from where did the ritual-norm connection originate? **Rossano** argues that the connection is a natural one given the deep evolutionary roots of ritualized behavior for unambiguous intention-signally. **Burghardt** sees the origin somewhat differently. Rituals arise from play. Play, too, has a deep phylogenetic history (an often underappreciated fact) as a means of fostering cooperation. Ritual (more accurately, ritualized behavior) and play share a number of features in common. However, whether this means one is derived from the other (and in which direction the derivation occurs) is an intriguing and potentially testable question that cognitive archaeology and its related disciplines may one day be able to address.

What were humanity's first rituals and what motivated their enactment? Both **Power** and **Sterelny** address these questions. At first blush, their accounts may seem at odds. Power focuses on reproduction, specifically what she calls reverse gender dominance. **Sterelny** views it from the perspective of reciprocal economic exchange. But it does not take long to realize that reverse gender dominance is motivated by reciprocal economic exchange. In order to secure necessary resources for their highly dependent offspring, mothers needed normative conditions that elevated the fitness benefits of pair-bonding at the expense of male philandering. Ritual created these conditions. It made the pair-bonded male/female economic exchange more reproductively profitable than alpha male resource-hoarding.

Mothers were not the only community "cliques" who utilized ritual's power to mold social conditions. **Hayden** argues that once resource surpluses became available, socio-pathic personality types used "secret" rituals to expand their influence over the community and promote their self-interests. The move from simple, egalitarian hunter-gatherers to more settled, complex hunter-gatherers was fostered by aggrandizers who used ritual to "legitimize" their higher status. As Henley (2018) notes, however, this move required that ritual be intertwined with supernatural belief. If the inspiration for this belief was (in part at least) derived from psychedelic-induced altered states of consciousness, as suggested by the deep evolutionary history of drug use explored in **Hagen and Tushingham's** chapter, then it would not be surprising that humanity's earliest rituals were highly emotive or imagistic in nature. Based on evidence from Göbekli Tepe, however, **Dietrich et al.** argue that as the hunting-gathering lifestyle was superseded by increased sedentism; emotive, imagistic rituals transformed into more conventionalized, doctrinal ones where the existing social order was supernaturally validated.

If **Whitley** is correct, then it may have been another "outlier mental state" – mood disorder – that precipitated this step toward religion. Supernatural belief requires an imaginative capacity far beyond that known to any nonhuman primate. Our ancestors may have acquired this capacity as a genetic "gift" from Neanderthals, which was then put to use by shamans for effecting healing and providing knowledge to their communities. One also wonders if **Gabora and Smith's** contextual focus hypothesis might not have played a role. Do mood disorders facilitate broad, novel associations that typical group members were unlikely to make? Though these novel associations might have been viewed as strange, there was something attractive and useful about them, which gave shamans an important influence over the group. If Big Gods played an important role in the emergence of civilization, then human "progress" may owe an important debt to "mental disorders" (as they are termed today). Then again, **Narvaez** and **Taylor** cautions us that viewing civilization as necessarily "progressive" is an assumption that may not stand well under critical gaze.

From rituals to language

Donald proposes that language cannot be understood without considering culture. Language, he contends, emerges from a distributed network of interacting minds, not as an evolved faculty of an individual mind. Once culturally based information

becomes essential to individual survival, the external social environment selects for brains able to acquire a flexible, representational communication system. **Power** considers one uniquely human aspect of culture necessary for the emergence of language: trust. Only a community where trust strongly outweighs suspicion stands to reap a fitness advantage from language. Following the anthropologist Roy Rappaport (1999), Power argues that ritual solidified the trust necessary for the emergence of language. Ritually-ensured trust means that community members will be motivated to share the kind of information that a symbolic, syntactically complex communication system can convey.

Ritual may provide the trusting social conditions for language, but this presupposes a mind that is ritually capable. What mental capacities allow for this? **Donald** and **Gabora and Smith** discuss these mental prerequisites: auto-cuing, the conscious recall-rehearsal loop, and self-monitoring. **Corballis** explores another: generativity, which he argues emerges from the ability to mentally organize spatial-temporal experience. It was recalling, re-organizing, and elaborating on these experiences that created the generative mental architecture that, coupled with trust, made language possible.

An attractive aspect of **Corballis'** scenario is its evolutionary continuity. That is, it does not envision the emergence of language as a sudden, "catastrophic" phenomenon as some (e.g., Bickerton, 1998) have claimed. Instead, its generative element grows out of the hippocampal-based spatial memory found in many mammalian species. This seems to connect nicely with the evolution of episodic memory outlined by **Krause and Sanz**. As they show, the "what/where/when" elements of episodic storage and recall have been demonstrated in a number of nonhuman species. Often this is referred to as "episodic-like" memory to distinguish it from the human form (something **Krause and Sanz** are critical of). One potentially important distinction between episodic-like memory and episodic memory is subjective experience (an important but empirically problematic distinction). Humans *re-live* episodic memories (rather than just recall them as with semantic memory). Might it be the reexperiencing that motivates linguistic transmission? It has been said that the reason chimpanzees do not use language is that they have nothing to talk about.¹ The reexperiencing of life's pains or pleasures, or the anticipation of those pains or pleasures, may serve as a powerful motivator for transmitting event-related information to others. **Fabrega** also considers the "problem of subjectivity" in the context of comparative psychology, suggesting that the psycholinguistic methods of Natural Semantic Metalanguage (NSM) could be retooled to uncover insights about the mind of various evolutionary creatures and early humans.

The powerful subjectivity of human episodic memory may give us something to talk about, but it also gives us something to dread. What if our subjectivity is wrought with what we perceived to be unending pain? This is the issue **Humphrey** takes up in his chapter on suicide. As he points out, one form of suicide – where personal death has benefits to kin and group – may have been selectively advantageous. But another – where one simply wants to avoid pain and hardship – is more likely a byproduct of our deeply subjective episodic memory. Similarly, **Pettitt** address the

broader issue of death itself, sketching out a cognitive prehistory of our understanding of death and our response to it. He identifies stages in the archaeological record moving generally from mortuary activity (what to do with dead bodies) to funerary activity (culturally variable “rules” for relating to dead community members). Funerary activity would appear to require more than just the awareness of death emergent from episodic memory. Symbolic and hypothetical thinking (“what if?”) that very likely require language would also seem necessary.

Generativity and episodic memory are part of the mental architecture necessary for language. It is noteworthy that neither of these qualities is present in the human brain at birth. They, along with language itself, are acquired slowly during the long haul of development – underscoring the fact that language is as much a developmental issue as it is a brain issue. Suppose that **Power** is right, and the first rituals were all about getting fathers to reliably provision their offspring. **Oxford and Geary** provide us with the reason why this provisioning was so essential. Over the course of human evolution, brains were expanding, development to maturity was slowing, and offspring dependency was increasing. Successfully raising a *sapiens* primate straddled the threshold of being a prohibitively labor and resource intensive task. Ritual met this challenge by helping to spread the costs across a broad social network. **Habecker and Flinn** explore this network in detail. Humans are unique, they contend, in that their offspring are embedded within multigenerational kin- and tribal-based cooperative networks. Within this social context, childhood evolved to be a critical period for acquiring fitness-relevant social and cognitive skills including, most notably, language. Language is complicated, and only a primate with a properly absorbent mind (i.e., one whose slow pace of development sensitized it to syntactically patterned vocal inputs) stood a chance of accomplishing the task.

As the “absorbent” mind put language and norms together, morality emerged. If morality is understood as a systemization of norms – that is, analytically organizing and prioritizing norms such that value judgments about actions can be derived – then language may have been essential to this transition. As **Krebs** shows, however, our moral judgments betray their normative roots: There is a measurable disconnect between our publicly proclaimed (linguistically mediated) moral reasoning and our everyday moral behavior. Morality is about selfish creatures seeking to reap the rewards of cooperation, not about consistently applying abstract principles.

Conclusion

Academia has its recurrent cycles, seasons, trends, and fads. This volume stands as one of a dozen or so similar works that in recent years have sought to juxtapose psychology and archaeology. Almost 20 years ago, Brown (1991) devoted chapter 3 of his book *Human Universals* to a history of attempts to align the presumed defining features of human nature – especially those posited by evolutionary, ethological, or comparative psychology – with anthropology and archaeology. Since the days of Wundt, the prospect that psychology could find human universals has waxed and

waned. So too has the acceptance of the possibility that such universals (if found) could provide any sort of useful framework for archaeology.

Cauvin's (2002) simple definition – that cognitive archaeology is merely the “matter of reconstructing prehistoric ‘cognition’” – would seem to be agnostic about the nature of the psychology involved. That is, it falls to us, as psychologists, to formulate an appropriate understanding of cognition that would assist the enterprise of cognitive archaeology. As noted in the Introduction, evolutionary psychology can surely be shown to be on the rise, and as a result there is a growing general acceptance that much about our behavior and cognition is to some degree determined by genetics and ontogeny. The three of us share this view, and so the contents of this edited volume no doubt reflect that perspective.

When one of us (MJR) suggested an organizational structure roughly mirroring that of a General Psychology text, we others quickly agreed, sharing a belief that much in our discipline could be of interest. Indeed, there is far more of value than a single volume could possibly touch on. As such we do want to underscore a point made in the Introduction – that the book is not comprehensive, but merely representative of the possibilities. Some obvious (but not purposeful) omissions including humor, mathematical cognition, motivation, music, writing, and many other topics – abnormality, aggression, health, power, theory of mind – surely deserved more attention than they received.

The current academic season is one receptive to bilateral exchange. As surely as psychology can benefit cognitive archaeology, so too can archaeology benefit psychology. Of course, that exchange is not for everyone. As also noted in the Introduction, many adherents of modern experimental (first) psychology see little relevance of much beyond their own research interests. Likewise, there are those in anthropology and archaeology who do not embrace the cognitive turn, and others still who do, but are rightly suspicious that not everything psychology has to offer would be useful. But, as this volume attests, there are many folks in the wider academic community who are enthusiastic in their support of interdisciplinary exchange.

Sympathetic readers from any of the disciplines involved, hopefully, have found ideas and insights here for future cross-disciplinary interaction. And at least three of those ideas are salient to us as we close. First, psychology is now mature enough to offer facts about human nature that surely could be used to develop and filter archaeological interpretations. Second, psychology also has many viable theories (especially about social behavior) that could be vetted in the context of archaeology. And last, psychology stands to benefit by further embracing the developments and discoveries from anthropology and archaeology.

Note

- 1 From a 2010 *New York Times* article by Nicholas Wade, who quotes primatologist Klaus Zuberbühler: “There is nothing to talk about for a chimp because he has no interest in talking about it.” See: www.nytimes.com/2010/01/12/science/12monkey.html 2019

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INDEX

Note: Page numbers in *italic* indicate a figure and page numbers in **bold** indicate a table on the corresponding page.

- abstraction 10–11, 153, 160–165, 180; bias toward 107–108, 115
- Acheulean xvii, 13, 29, 153, 158–160, 241–242; cognitive mechanisms in 252–255, *254*; neural pathways and resonance in 247–249; neural substrates of aesthetic response in 249–252, *251*; normativity in 154–157; symmetry and trends in 242–247, *244, 246*
- adaptation xiv–xvi, xx–xxii, 11–15, 21–28, 108, 433; and the Acheulean handaxe 248, 255; adaptive functions of moral traits 9, 86, 93–101, 128, 155, 363; and aesthetic experience *247*; and endurance hunting 394n2; and the evolution of language 288–290, 292, 294; and expert technological cognition 267, 278–279; extrasomatic adaptation xii, 220, 403; and fire 416–418, 422, 426; and generativity 144, 147–148; and hormonal mechanisms for human family relationships 58, 60, 64–65, 76–77; and human cognition 153, 155, 162, 164; and human sexual dimorphism 45, 47, 394n10; and learning and memory in humans 196–197, 201–207, 212–214; and life history evolution in hominins 36, 40, 42, 44–45, 47, 51; and madness 451, 462–463; and mark-making *251, 255*; and norms 380, 382; and play 128; and psychoactive drug use 472, 475, 477; and psycho-cultural change 326; and ritual 339, 348; and suicide 502–504, 505, 509; and symbolic cognition 355–356, 363, 365; and transitions in the archaeological record 220, 222–223, 226, 228–230, 233; *see also* adaptive hypotheses
- adaptive hypotheses 174–176, **175**, 191–192; comparative perspectives on 183–190, *185, 188–189*; contrasting perspectives on 176–177; and episodic memory 180–183, *181–182*; implications for cognitive archaeology 190–191; and the survival processing effect 177–180, *178*
- adolescence xxi, 9, 28, **41**, 44, 48; and psychoactive drug use 478–481, *478*
- adulthood 36–39, **41**, 43–45, 477–480
- aesthetic 241–242, 244–252, 251, 276–279; proto-aesthetic 244, 246–247, 251, 255
- affordance 213–214, *254*, 263–264, 407–408
- aggrandizer 14, 439, 447, 530; aggrandizer strategies 435–437, 445
- aggression 105–106, 323–324
- agriculture 16–19, 311–312
- alcohol 471–473; beer 436, 486–487; ethanol 15, 482–484, 486–487; grog 486–487; wine 486–487
- alliances 62–65

- allocate 13–14, 26, 316, 357, 360–361;
 allomothering 26–27, **41**; alloparenting 9,
 42, 45, 74, 357
 allocentric 253
 Altamira, Spain 346, 359
 altered states of consciousness (ASC)
 432–434, 445–447, 530; and madness
 452, 457–459, 458, 461; and psychoactive
 drug use 485–486
 altriciality 21–22, **40**, 48–49, 58–60, 77
 amygdala 68–75, **69**, **73**
 anadenanthera 485–486
 anthropoid 40, 279; anthropoid primates 46,
 267–268
 Apollo 11 Rockshelter, Namibia 459
 apprenticeship 12, 263, 266, 276–277, 280
 archetypes 431
 architecture 319–321, 435–437, 531–532
 arginine 63, 66
 art 15–16, 431–433, 455–461, 486, 521–523
 aSMG 253–254, 254, 278
 association 140–141, 190, 224–225,
 228–229, 233, 266–267, 517–524; *see also*
 thought
 attachment 23–24; hormonal basis for
 65–76, **68–69**, **73** attention 227–228,
 248–252, 251, 265–267, 277–279,
 338–339, 354–357
 Aurignacian 418
Australopithecus 22–23, 45, 222–223, 294
 autism spectrum disorder 49–50, 71, 452,
 465n2
 autonoesis 140

 Back to Africa hypothesis 464
 Baldwin, James Mark 342; Baldwin effect
 126, 278
 baselines 104, 115; and cognitive
 archaeology 113–115; ghost theories
 and fishbowl views 104–111; and nature
 disconnection 111–113
 beads 13, 161–162, 336, 344–345,
 347–348, 365, 431 behavior xiv–xxii,
 3–4, 6–13, 27–29, 528–529, 532–533;
 and the Acheulean handaxe 242–245,
 248–250; antisocial 100, 423; and expert
 technological cognition 267–268;
 and fire 415–416, 418, 420–427; and
 generativity 138–143; and hominin
 mortuary activity 512–515, 518–524;
 and hormonal mechanisms for human
 family relationships 59–61, 64–72, 74–76;
 and human cognition 153, 155–156,
 158, 160–164; and the inextricability of
 science and religion 296–298, 300–306;
 and learning and memory in humans
 174–176, 183–188, 191–197, 200–207,
 210–214; and life history evolution in
 hominins 38–39, 42–45, 49–50; and
 madness 452–455; maladaptive 213;
 moral 87, 90–92, 95, 99, 101, 532;
 and morality 96–100; mortuary 143,
 513–520, **516–517**, **519**, 522; and norms
 381–383; and play 120–121, 123–130,
 124; and prehistoric sexuality 398–407,
 409–411; and psychoactive drug use
 471–472, 475–477, 483–485; and
 psycho-cultural change 322–324; and
 psychology in archaeology 431–436,
 440–442; and psychology and cognitive
 archaeology 107–108, 114–115; and
 ritual 335–339, 342–348; ritualistic 127,
 301; and suicide 501–502; and symbolic
 cognition 355–358, 366–369; and
 transitions in the archaeological record
 220–223, 231–232
 behavioral ecology xv, 205, 207, 213
 behavioral modernity 11, 50, 221, 232, 512
 Belladonna (*Atropa belladonna*) 485
 betel nut 475, 488
 bifacial cutting tool 154, 275
 Bilzingsleben 244, 244, 252, 417–418
 biparental care 39–40, 75–77, 361
 bipolar disorder 15, 433, 452, 455, 462, 465n2
 blacksmithing 12, 262–263, 267, 277
 Blombos 244, 252, 345
 blood 476, 514; menstrual blood 363–364,
 370; *see also* *ekila*
 blood brain barrier (BBB) 473–474, 492
 blue lotus (*Nymphaea caerulea*) 485
 bonding 62–67, 74–76, 403–405, 530
 bone 162–163, 244–246, 244; elephant bone
 246, 246
 bonobos 23, 29, 46, 146; and the
 evolution of language 291; and expert
 technological cognition 271; and learning
 and memory in humans 184, 187–188,
 188; and norms 385; and ritual 339; and
 symbolic cognition 356
 Boussou, Guinea 268–276, 279
 bow and arrows 10–11, 164, 279, 286–287
 brain 47–48; anterior insula 250; brain scans
 245; inferior parietal cortex 253; lateral
 occipital cortex 245; lunate sulcus 46;

- myelination 44; neurocranial globularity 42; orbito-frontal cortex 249–250; prefrontal cortex (vPFC) 24, 29, **41**, 44, **69**, **73**, 143, 182, 226, 245, 249–250, 278–279, 343; supramarginal gyrus (aSMG) 249, 253, 254, 278; ventral visual pathway 245–246, 249, 253, 255; *see also* cerebellum; neocortex; visual cortex
- brain evolution 29, 39, 291, 420
- brain size 9, 14, 22–24, 38–39, 224–225, 367–362, 418–419; cortical expansion 38; and development 45–46; gray ceiling 47, 357
- bride service 362–363, 368, 393
- Bruniquel Cave 346–347
- burial x–xi, 11–13, 344–345, 347–348, 435–437, 445–447; and hominin mortuary activity **516–517**, 518–523, **519**; and psychoactive drug use 485–491
- byproducts 5, 191, 225, 531; and the Acheulean handaxe 245, 251, 255; and norms 390; and psychoactive drug use 476, 482; and ritual 348
- cacao (*Theobroma cacao*) 15, 487–488
- canine teeth 46–48, 402–404
- cannabis 475, 486, 488–490
- cannibalism 440–441, 444–447, 514, **516**, **519**
- canonical function 339
- capuchins 268
- cassina (*Ilex vomitoria*) 488
- Catalhöyük 322, 325
- Cauvin, Jacques xiv–xv, 3, 5, 16, 311–312, 326, 533
- caves 344–348, 407–408, 416–418, 445–447, 459–463; cave art 138, 226, 460, 521; and hominin mortuary activity 515–522, **516–517**
- cemeteries 16, 410, 514, 518, **519**, 523
- cerebellum 40, 50, 59, **73**, 231, 253, 278
- chaîne opératoire 255, 272, 275, 522
- Châtelperronian period 463
- Chauvet Cave, France 347, 359, 460
- cheating 100, 122, 380–383
- chemical residue analysis 485–487
- chess 262, 264; King's Indian Defense 266
- Childe, Gordon xi
- childhood 21–23, **41**, 42–44, 58–61, 108–110, 532; and norms 390; and play 129–130; and symbolic cognition 356–357, 370
- chimpanzee 23–25, 40–48, 60–62, 65–66, 146, 527–528; and expert technological cognition 268–276, 268; and human cognition 153–154; and learning and memory in humans 187–190; and ritual 334–339; and prehistoric sexuality 402–403; and symbolic cognition 356–358
- circadian rhythms 462
- civilization 4–5, 105–114, 409–410
- coalitions: coalitional competition 39; cosmetic coalitions 13, 362–364, 366, 370; female coalitions 361–366, 369–370; primate coalitions 338, 361
- coca 488
- cognition xvi–xxii, 3–4, 6–14, 58–67, 528–529; and abstraction 160–164; and the Acheulean handaxe 241–242, 247; and the evolution of language 287–288; and fire 423–424, 427–430; human cognition 153–154, 164–165; integrated cognition 228, 230; and learning and memory in humans 197–208, 212–215; and normativity 154–157; and recursion 157–160; and ritual 334–335; symbolic 354–370; technological 261–280; and transitions in the archaeological record 221–225, 228–233; *see also* thought
- cognitive control 12, 267, 270
- cognitive development 60, 289
- cognitive fluidity 11, 224, 229, 231, 376, 386
- cognitive map 186
- cognitive models 267, 279
- cognitive neuroscience 6, 181, 267, 416
- cognitive niche 147, 359
- cognitive transition 222–230
- collective action 376–379, 383–387
- communication 50, 58–60, 201–202, 292–294, 318–320; language as 145–148; meta-communication 125; and symbolic cognition 354–355, 365–366
- communities 62–65, 301–303, 311–320, 325–326, 407–411, 441–447; cultic community 319–321
- comparative psychology xxi–xxii, 200, 207, 214, 531–532
- computational models/theories xx, 214
- concealed ovulation 40, 363
- conflicts of interest 10, 88, 94–96, 99–100
- consciousness 5–6, 196–205, 212–214, 451–452, 458–459; evolution of consciousness 200–207, 212, 451

- contextual factors 88–90, 227
 contextual focus 227–233, 234, 530
 continuous receptivity 360
 conventionalization 147, 367
 cooking 12–14, 418–422, 425–426
 cooperation 9–10, 93–101, 155–156, 322–325, 334–337, 365–366; the
 conundrum of cooperation 94; and fire
 426–427; and psychoactive drug use
 375–383, 386–393
 cooperative breeding 22–23, 28, 40, 49, 298,
 357–361
 cooperative childcare 27, 356–358; *see also*
 allocare
 cooperative hunting 155, 164, 298, 300, 300,
 322
 core geometry 246
 co-residential males 62
 corpse disposal 143, 513–514, **519**, 521
 cosmetics 13, 363–364, 367, 370, 408;
 bodypaint 367; red 364–367, 370
 Coso Range, California 456, 457, 458
 costly rituals 13, 322–323, 326, 334, 337,
 341–348, 365–367
 costly signaling 322–323, 326, 362, 365–367
 craft 123, 262–265, 280, 385
 creativity 123–126, 223–224, 455–457,
 461–464; creative genius 452, 461
 cryptic ovulation 45, 63
 cues 62–63, 76, **175**, 176, 186, 190; and
 the Acheulean handaxe 246, 250; and
 expert technological cognition 263–269,
 273–276, 279–280; and norms 384; and
 psychoactive drug use 476, 482; and
 ritual 333; and symbolic cognition 363;
 and transitions in the archaeological
 record 222–223
 culture: cultural evolution 220–223,
 233–234, 251; cultural transformation
 436; cultural transmission 126, 290, 355,
 358–362, 477–484; cumulative culture
 296–297, 302–306; episodic culture 128;
 mimetic culture 128, 147, 291; mythic
 culture 129; socio-cultural factors 248;
 symbolic culture 362–265, 405, 409–410;
 theoretic culture 129
 curation 275, 420, 514, **519**, 523
 dance 438; and the evolution of language
 291; and generativity 146; and norms 389;
 and play 122–124, 124; and ritual 340,
 342; and symbolic cognition 366, 369
 Darwin, Charles x, 7, 137–139, 196–200,
 212–214, 435; and prehistoric sexuality
 402–404
 datura (*Datura sp.*) 485–486
 Deacon's dilemma 361
 death 15–16, 22–24, 50–51, 120–123,
 441–444, 531–532; chemical responses
 to 515, 518; emotional responses to 324,
 512, 515, 518; and generativity 142–143;
 and psycho-cultural change 324–327;
 rationalization of 515, **519**; *see also*
 mortuary activity; suicide
 decision-making 91–92, 97–101, 277–279,
 383–384; Type 1 vs Type 2 decision-
 making 92, 100, 265, 529; Type 1
 processing 228; Type 2 processing 101,
 229
 Denisovans 139, 147, 405–406, 461
 dental calculus 490–492
 development xxi–xxii, 8–10, 18–25, 28–29,
 106–114, 431–432, 436–437; brain
 and 47–50; developmental disruption
 model 480; and fire 424–426; and the
 evolution of language 288–292; and
 generativity 147–148; and hominin
 mortuary activity 513–515, 518–522;
 and hormonal mechanisms for human
 family relationships 59–65, 75–77; and
 the inextricability of science and religion
 303–304; and learning and memory
 in humans 182–183; and life history
 evolution in hominins 36–45, **40–41**;
 moral development 97–98; and morality
 88–91; and prehistoric sexuality 399–403;
 and psychoactive drug use 480–482; and
 psycho-cultural change 311–312; and
 transitions in the archaeological record
 231–232
 developmental psychology 8–9, 129
 Diepkloof 252
 diet 20–21, 419–420
 dimorphism xxi, 14, 45, 59, 394, 402–404,
 409; body size 38, 46–49, 410, 419
 displacement 139–143, 226
 DNA 402, 406, 461–462, 526; aDNA 400,
 405
 domestication 311–312; plant domestication
 111, 311, 484; *see also* domestic fire
 domestic fire 415–416, 427; and the context
 of early human fire use 420–423; the
 emotional implications of 424–426;
 origin of 416–420

- dominance: counterdominance 359, 362, 364; dominance hierarchy 357–358, **378**, 390; male dominance 108, 358–359, 364, **378**
- Donald, Merlin xiv, 12, 128, 140, 147, 203, 223–224, 507, 530
- dopamine 71–72, 76; mesolimbic dopamine system (MDS) 471–472
- drama 123–124, 124
- drug use 471–476, 483–493; sex differences in 477–482
- dual-process theories 87, 91–92, 95, 100–101
- Durkheim, Émile 355, 364, 367, 502, 506
- ecological psychology *see* affordance
- ecology xi–xii, xxi–xxiii, 42–44, 47–48, 59–61, 111–114; behavioral xv–xvii, 205–207, 213; and endurance hunting 394n2; and the evolution of language 289–290; and learning and memory in humans 205–207; reproductive 37–39, **41**, 45
- egalitarianism 354–355, 370; and cultural transmission 358–361; and the FCC model 367–370; gender egalitarianism 370; hunter–gatherer egalitarianism 359; and intersubjectivity 355–358; reproductive egalitarianism 360, 368; and reverse dominance 361–364; and ritual 365–367
- ekila* 369–370
- emotions 13–15, 44–45, 431–434; and aesthetic experience 247; emotion regulation xxii, 14, 60, 64, 70, 74, 393, 416, 423–427; and fire 415, 422–427; and generativity 149–150; and hominin mortuary activity 512–515, 518–521; and hormonal mechanisms for human family relationships 58–61, 64–66; and madness 451–454; moral emotions 45, 92, 95, 101; and morality 88–92, 99–101; and norms 380–381, 392–393; and prehistoric sexuality 399–400; and ritual 337–341; and suicide 503–505; and symbolic cognition 365–367; and transitions in the archaeological record 232–236
- empathy 29, 423–425
- emulation 12, 269–271, 274, 300; *see also* imitation
- encephalization 59, 361, 367, 370, 379; and prehistoric sexuality 402, 405–406, 410
- endorphins 250
- entheogens 485
- entorhinal cortex 10, 143
- episodic memory 11, 29, 140–142, 144, 531–532; and the evolution of language 292; and learning and memory in humans **175**, 177, 179–187, *181–182*, 185, 190–192; and ritual 334
- ergonomics 248, 250, 263
- Ethiopians 464
- ethnographic research 279
- ethology 113–114, 127–129; cognitive ethology 197, 200, 214
- evolutionary psychology xiv–xvi, xx–xxi, 3–5, 7–8, 178–179
- evolutionary transitions 221–222, 233–234
- evolution of language 12, 29, 199, 287–288, 294, 354–356, 364–366; key cognitive preconditions for 288–294
- evolved nest 10, 108–109, 112
- exclusive mating 62
- expertise 264–271, 275–280, 529; expert performance 264–265, 267, 279
- externalization 139–140
- extrinsic mortality 37–38
- faculties 334; cognitive 164; human 140, 164; of language 137, 530
- family 58, 61–65, 77, 96–98, 357–358, 391–393; and evolution of mind 58–61; family environment 61, 77, 96; and forager sexual division of labor 394n8; and neurological and physiological mechanisms 65–76, **68–69**, **73**; and suicide 502–503
- fathers 25–28, **41–44**, **62–63**, **72–77**, **526–527**
- fear 14–15, 110–111, 324–325, 504–508; *see also* terror
- feasting 13–14, 320–326
- feedback xvi, 158–160, 361
- females: female competition 37–39, 62–65, 356–358, 363–364, 403–404; female cosmetic coalitions hypothesis 366, 370; female philopatry 355; female reproductive costs 48, 358–361, 366; female strategies 355, 358, 361, 370, 403; *see also* fertility; kin
- fertility 36–40, 360–364, 479, 480–481, 481, 392
- fictions xx, 130, 361; social/shared fictions 359, 364; supernatural fictions 364
- fine motor control 253

- fire 274–276, 291–294, 379–383; controlled fire use xxii, 222, 225, 415–418, 420–422, 427; fire making 14, 416, 421–422; opportunistic fire use 416–417; *see also* domestic fire
- flake: flake propagation 273; stone flake 156–158, 272–277
- fluency 244, 250
- folk theory 263–264, 270–277, 280
- food production 44
- forager sharing norms **378**, 383, 391–392
- FOXP2 11, 50, 230–234
- Freud, Sigmund 16
- funerary activity 514, **519**, 523, 532; funerary caching 518–522, **519**; mortuary activity 512–524, 532
- gender 354–355, 370, 406–411, 479–480; and cultural transmission 358–361; and the FCC model 367–370; and intersubjectivity 355–358; and reverse dominance 361–364; and ritual as costly signals of commitment 365–367
- gene-culture co-evolution 96–97, 393
- generativity 10–12, 137–138, 143–145, 148, 531–532; and displacement 139–143; and language 145–148; and reaction against the great leap 138–139
- genes 24–25, 70–71, 93–97, 113–114, 230–233, 404–405, 461–462; genetic explanations 230–231; genetics 11, 190, 293, 533; and schizophrenia 465n2
- Gesher Benot Ya'aqov 12, 274–277, 275, 417–418
- Gestalt 248, 252, 404
- gestation 41–42, **41**, 405–406
- gestures 145–148, 243–245, 304–305, 338–339, 528–529
- glacial periods 161, 386
- Göbekli Tepe 13, 15, 130, 445–446, 448, 530; and animals in iconography 320–325; and psycho-cultural change 313–320, *313–319*, 325–327
- grammar 213, 233–234; generative grammar 137; universal grammar 137–139
- grandmothers 26–28, 41–45, **41**, 356–357, 382–385; grandmother hypothesis 49, 356, 390
- grandparenting 9, 58, 63
- grave goods 519–522, **519**
- Grice's cooperative principle 367
- grid cells 143–144
- grooming 39, 339, 410, 425, 485
- groups: cohesion 314, 322–326, 340, 416; group binding 305; group boundaries 324, 341, 367; group commitment 337; group competition 322, 336–337, 339, 529; group hunting 93, 384; group identity 14, 229, 324, 367; group size 101, 359, 515, 518
- habit 162, 164, 299, 384, 403, 417, 421; habituated practices 254
- habitus* 407
- Hadza 26–27, 339, 368–369, 393, 394n4
- hallucinogens 15, 452, 459, 476, 485
- handaxe xvii, 12, 29, 528; and the Acheulean handaxe 241–242, 252–255, *254*; and the evolution of language 292; and expert technological cognition 275–279, 275; hafting 158, 160, 162–164, 292, 383; and human cognition 154, 156–158, *157*; and the inextricability of science and religion 299, 302; and neural pathways and resonance 247–249, *247*; and neural substrates 249–252, *251*; and norms 385; and prehistoric sexuality 403; and symmetry and trends 242–243; from symmetry to patterns 243–247, *244*, *246*
- hearth 415–417
- Heinz dilemma 88–90
- hemineglect 143
- Hijack hypothesis 471–472
- hippocampus 10, **73**, 75, 140–144
- hominin xiii–xv, xxi–xxii, 51, 59–60, 146–148, 528–529; and the Acheulean handaxe 241–242; early *Homo* 47–49; and endurance hunting 394n2; and expert technological cognition 267–268, 271–280; and the evolution of language 288–294; hominin evolution 22, 46–47, 202, 271, 274, 277, 389, 514–515; hominin fossil record 45–46; and human cognition 154–160, 164–165; and human life history 40–45, **40–41**; and impulse control 394n3; later *Homo* 49–50; and learning and memory in humans 190–191, 199–202; and life history theory 36–40; mortuary activity of 512–524; and norms 375–382, 389–393; and prehistoric sexuality 402–405; and ritual 336–337, 344–345, 348–349; and symbolic cognition 354–355, 357–360; and transitions in the archaeological record 221–223

- Homo*: early *Homo* 47–49; later *Homo* 49–50; speciation 368
- Homo erectus* 9, 11, 12, 47, 147, 154–155; and the Acheulean handaxe 243–244, 248, 252; and the evolution of language 291–292, 294; and fire 418–420; and the inextricability of science and religion 297, 299, 300; and learning and memory in humans 210–202, 210; and norms 379; and symbolic cognition 357–358; and transitions in the archaeological record 223
- Homo ergaster* 147, 418–419
- Homo heidelbergensis* 243–245, 248, 252, 299, 300, 419–420, 424; and hominin mortuary activity **516**, 518
- homo necans* 323
- Homo sapiens* x, xiii, xiv–xv, xxi, 9, 11, 13; and the Acheulean handaxe 248; and fire 415, 419–421, 424; and hominin mortuary activity 513, 518–520, **519**, 522; and human cognition 161, 164; and learning and memory in humans 180, 183, 197–200, 204–206, 212; and life history evolution in hominins 50; and generativity 138–139, 142, 147; and prehistoric sexuality 405–406; and ritual 333–335, 337, 344–348; and symbolic cognition 355, 361, 366; and transitions in the archaeological record 226, 232
- Homo sapiens sapiens* xxi, 243, 405–406, 451
- Howiesons Poort 161, 163–164
- Hrdy, Sarah 354–357, 382
- human evolution xiii–xiv, xix–xxi, 115, 432–433, 532; and the evolution of language 294; and expert technological cognition 280–281; and fire 427; great leap forward in human evolution 137–139; and play 122, 126–127; and suicide 509; and symbolic cognition 361–363, 370;
- human nature 105–109, 113–115, 431–433, 532–533
- human sacrifice 437, 446
- hunter-gatherer: African hunter-gatherers 356, 359, 362, 365, 368–370; hunter-gatherer cosmology 364; hunter-gatherer egalitarianism 355, 359–360, 365, 368–370; recent hunter-gatherers (RHGs) 9, 20–22, 25–28, 312
- hunting xx–xxii, 59–61, 154–156, 298–300, 300, 527–530; and norms 378–387, **378**, 391, 394n2; and psycho-cultural change 322–325
- husbandry 311
- identity 324–325, 367–369, 389–392, 399–400; identity fusion 324
- ideologies xii–xiii, 435, 437, 441–442, 445, 447; and psycho-cultural change 312, 326
- imagery 311–312, 319–321, 324–325, 457–459, 458, 461
- imitation 12, 153–154, 176, 231–232, 274–276, 300–306, 301; overimitation 11–13, 153–156, 300–305, 529
- immediate return mutualism 14, 376, **378**, 379, 381, 386
- inbreeding avoidance 64
- inclusive fitness 15, 37, 390, 502
- indexical function 339
- indigenous cultures xxiii, 115
- individualism 106–107, 112, 337, 348, 399
- infancy 21–28, 39, **40**, 42; altricial infant 22, 42, 48, 60; and hormonal mechanisms for human family relationships 59–60, 63–67, 72–75; and human cognition 155–156; and the inextricability of science and religion 296–297; and prehistoric sexuality 403–405; and psychoactive drug use 490–491; and symbolic cognition 359–360
- infanticide 63, 356, 359–360, **519**
- initiation 324–325, 341–342, 392–393, 438–440, 443–444
- injury 75, 243, 252, 285, 423
- interbirth interval 9, **40**, 60, 360
- intelligence 58–59, 108–112, 229–231, 304–305, 359–361, 431–433; technical intelligence 304
- intentionality 125, 128, 201, 251, 293; shared intentionality 298, 300, 354–355
- intention reading 299
- internal language (I-language) 137–140, 145, 204
- intersubjectivity 23, 355–359, 370, 425
- intraspecific competition 46
- introgressive hybridization 15, 452, 461–463
- intuition 94–95, 100–101
- Inuit 110, 453
- invariant properties 245
- isochrestic style 251–252
- iteroparity 37

- Jebel Irhoud 50
 juveniles 27–28, 38–44, 269–270
- Kanjera 272
 Kanzi 271
 Karamazov brothers 526
 Khoesan 368–369
 kin 58–65, 360–364, 390–392, 445–447, 531–532; kinship networks 40–41, **41**, 77, 225, 447, 532; kin-selection 14, 19, 26, 63, 390, 502
 knapping 156–160, 244–246, 271–280, 305, 417; stone knapping 271, 274, 276–277, 279–280
 Kohlberg, Lawrence 87–92, 97–99
- La Ferrassie, France 347, **516**, 518, 520, 522
 language 5–6, 10–14, 23–25, 40–43, 46–50, 58–59; as communication 145–148; conspiratorial whispering 366; and expert technological cognition 277–280; faculty of 137, 140, 530; and generativity 137–140, 143–148; language origins 287; and learning and memory in humans 183–184, 196–199, 201–202, 204–207; ostensive-inferential nature of 146; and play 125–126; rituals and 530–532; speech 48–50, 147–148, 231–232, 365–367; as thought 137–139, 144–145, 148, 261; and transitions in the archaeological record 226–234; as underdetermined 145; *see also* evolution of language
 language of thought and experience (LOTE) 196–200, 206, 208, 212–214
 Lascaux, France 345–347, 445–447, 459
 learning xvi–xvii, 27–29, 37–45, 59–61, 95–97, 123–126; comparative perspectives on 183–190, *185*, *188–189*; contrasting perspectives on 176–177; and cumulative culture 296–297; and episodic memory 180–183, *181–182*; and expert technological cognition 265–270; and generativity 139–140; and implications for cognitive archaeology 190–191; and the inextricability of science and religion 299–300, 303–305; and learning and memory in humans 174–176, **175**, 191–192; and norms 384–385; and psychoactive drug use 474–475; and the survival processing effect 177–180, *178*
 Levallois 158–159, 276
 life history 51, 60–61, 77, 356–357; and early *Homo* 47–49; and the hominin fossil record 45–46; human life history 40–45, **40–41**; and later *Homo* 49–50; life history evolution 36–37; life history theory 36; live fast die young 9, 37; live slow die old 9, 37, 40; primate life history 37–40; slow life history 37–38; stages **40**, 60–61, 77, 357
 linguistic instruction 277, 280
 lithics 241, 299–302, 347, 358
 Lokalelei 2C 12, 271–274, 272, 275–279
 Lomekwi 3 222, 272
 Lucy's child 22
- macaques 25, 268, 381, 403
 Machiavellian intelligence 355, 359, 364
 males: alpha 13, 361–363, 370, 390, 402–403, 501, 530; domestication 358; dominant behavior 62, 358–364, 369; investment 14, 37–38, 45–46, 62–63, 75, 360–361, 389–391; strategies 355, 358, 361, 370
 manual dexterity 243–245, 255
 Marines vs. hippies 337–338
 mark-making 244, 251, 252, 255
 masks 321–322, 440–443, 447
 mate-recognition 364
 mating 36–38, 44–45, 62–65, 75–76, 338–340; mating effort 36–37, 360, 391; mating system 46; *see also* reproduction; sex
 matrilocality 13–14, 362, 368
 Mbuti 369
 medicine 485–487; medical diagnosis 262, 264
 Melanesians 442, 446
 memory: chunks 265–267, 270, 279; declarative memory **175**, 183; long-term memory (LTM) 12, *181*, 263–267, 270–271, 279–280; long-term working memory 265, 279; motor memory 263; procedural memory 12, 293; semantic memory 181, 261, 324, 531; short-term memory (STM) 177, 265–267; working memory xxii, 175–176, **175**, 225, 248, *251*, 265–267, 270–271, 277–279, 423–427; visual working memory 248, 277
 menopause 9, 40, 49, 64, 303, 356, 370
 menstruation 363, 369
 mental apparatus 196–197, 204

- mental illness 452–456, 459–464; major depression 15, 452, 462; *see also* bipolar disorder; mood disorders; schizoaffective disorder; schizophrenia
- mentalization 199–204, 207–208, 212–214
- mental time travel 10–11, 147, 181, 183, 185, 229; and hippocampal function 140–143; in nonhuman animals 140, 180, 184, 186–187, 191–192
- metabolic cost 41, 59
- metaphors of ASC 457–461
- mimesis 10, 12, 123, 124, 291–292
- mind-reading 13, 298, 355–359, 365; *see also* theory of mind
- Minimalist Program 137, 139
- Miracle in the Andes 333
- mirror neurons 231, 270
- modern humans: anatomically modern humans 232, 252, 290, 293, 302, 323, 345, 451, 463, 522; cognitively modern humans 14–15; emotional modernity 451–452; *see also* behavioral modernity
- Mohave 453–454
- molars 22, 40–41, 42, 45, 48
- monogamy 38–39, 74–75, 359–360, 403–405; serial monogamy 360
- monuments 445, 448; *see also* Göbekli Tepe
- mood disorders 452–457, 461–464, 465n2, 530
- morality 9–10, 86–101, 120–122; infant and juvenile 86; ultimate principles 101
- moral development 88–91, 95–98; stages of moral development 88–89, 91, 97, 532
- moral judgment 90; functions of moral judgment 92, 95, 98–101
- moral reasoning: first person moral reasoning 90–91; flexibility in moral reasoning 89; hypothetical vs. real-life moral reasoning 89–90; and moral behavior 90–91, 99, 532; moral decision-making 10, 88, 91–92, 97–98, 100–101; moral exemplars 91; moral intuitions 95, 100–101; third person moral reasoning 90, 99, 155
- mortuary activity 512–514; and evolutionary development 514–520, 516–517, 519; and symbolic systems 520–524
- muscular bonding 340–341
- music 122–124, 124, 129–130, 262–266, 431–432; musical performance 262–264
- Neanderthals x, 9, 14–16, 49–50, 138–139, 199; and the Acheulean handaxe 243, 252; and fire 419–421; and hominin mortuary activity 516–517, 518–520, 522–523; and the inextricability of science and religion 296, 302; and madness 461–464; and prehistoric sexuality 405–406; and ritual 334, 344–348; technology of 138–139, 386; and transitions in the archaeological record 226
- necrophoresis 514, 519
- Neolithic xiv, 3–5, 13, 130, 407, 445–446, 486; early Neolithic 130, 311–313, 321–327; Neolithization 311–312, 326, 410; Pre-Pottery Neolithic (PPN) 311, 315, 318, 321–322, 445–446; Pottery Neolithic (PN) 311; *see also* Göbekli Tepe
- neural networks 245, 247–250, 255, 267, 278; discrimination network 266
- neurophysiology 252, 257; neural interconnectedness 245, 249; neural load 248; neural tracts 244, 255
- neuroscience xix–xxi, 177, 181, 192, 230, 241–242; neuropsychological model 458–459, 458; social neuroscience xx; *see also* cognitive neuroscience
- neurotoxin regulation hypothesis 476–477, 480
- Neurovisual Resonance Theory 247–248
- Nevali Çori 312
- Ngoku* 369–370
- nicotine 15, 471–476, 480, 489–491, 490
- normativity: normative guidance 376, 385–386, 393; normative motivation 301, 303–304, 375–376, 385–388
- norms 12, 14, 87–88, 96–97, 155–156, 527–529; evolution of 375–393; and fire 426–427; and the inextricability of science and religion 300–301, 300; moral norms 87–88, 92, 96–97, 362; and prehistoric sexuality 400–401, 405–407; and ritual 336–337
- notched bones 11, 162
- Natural Semantic Metalanguage (NSM) 196–200, 203–210, 212–214, 531
- nut cracking 12, 268–269
- obligate cooperative foraging 336
- ocher 13, 244, 344–345, 347–348, 366–369, 520–521
- Oldowan 154–156, 191, 288–290, 299–300, 300, 527–528

- opioids 471, 473; mu-opioids 246; opium 486
- overdetermination 276–279
- ovulation 40, 45, 63, 360, 363
- oxytocin 29, 72–74
- Palaeolithic: late 153, 161–162, 165; middle 157–160, 159, 302, 347, 421, 513, 520–523; *see also* Upper Palaeolithic
- pantomime 146, 223, 364
- Papuans 461
- parenting 62–63, 71–73; parental investment 14, 36–38, 45–46, 60–64, 75, 360–361, 389–391; *see also* allocate; biparental care
- patterns 21–23, 36–38, 50, 58–60, 143–144, 198–199; and the Acheulean handaxe 243–247, 244, 246; of drug use 490–492; and expert technological cognition 262–263; and learning and memory in humans 212–214; and madness 457–458, 458; and norms 383–384; and psychoactive drug use 484–486
- Pech-Merle, France 459
- perception 108–110; and madness 458–459; and transitions in the archaeological record 222–223, 241, 247, 247, 250, 253
- percussion 268, 271, 447, 485
- personality traits 341, 431, 433–436; assertive style 250–251, 251; passive style 251, 251; theories of 433
- person perception 250
- peyote (*Lophophora williamsii*) 485
- Plato 107, 123, 399, 455
- play 39–43, 41, 109–110, 120–130, 338–339, 409–411
- Pleistocene: Early 147, 357, 360, 377; Late 14, 365, 368, 378, 379, 386–387, 389, 391–393; Middle 242, 255, 358, 370, 416–422, 524
- Qafzeh Caves 160–161, 345, 347, 518, 522
- recipe 263, 487
- reciprocation 376–379, 386–383
- recursion 10–11, 153, 157–160, 159, 165; and transitions in the archaeological record 225, 230, 234
- recursive mind-reading 298
- refinement 242–243, 382–383
- refitting 272–274
- reflex 175, 246, 399–400, 407; smile reflex 246
- Regourdou 520, 522
- religion xii–xv, 5–6, 10–13, 120–123, 126–129, 528–530; afterlife 15, 143, 161, 508; axial religions 127; doctrinal 13, 324–326, 530; imagistic 13, 324–326, 530; and the inextricability of science and religion 296, 303–306; proto-religion 128; and ritual 342–344
- reproduction 13–14, 36–41, 41, 43–51, 59–66, 528–530; and the evolution of language 291–292; and the inextricability of science and religion 301–304; and learning and memory in humans 205–206, 213–214; and morality 92–93, 98–100; and norms 389–390; and prehistoric sexuality 401–409; and psychoactive drug use 471–472, 480–481, 490–492; reproductive ecology 37–39, 41, 45; reproductive effort 9, 36–37, 362; and symbolic cognition 356–364, 370
- resonance 247–249, 247
- retrieval structure 265–276, 279–280
- Rhino Cave 346–347
- ritual 10–15, 120–131, 124, 302–306, 333–340, 435–448; gender ritual 354–364, 367–370; and madness 456; and norms 388–393; overimitation and 300–301; and prehistoric sexuality 405–406; and psychoactive drug use 485–488; and psycho-cultural change 320–326; *see also* costly rituals
- ritual healing theory 485
- ritualized behavior 338–339, 529
- ritualized display 363
- Rossano, Matt 13, 120, 127, 129, 344, 365–366, 426–427, 529
- scavenging xiv, 298, 378, 379 scene construction 141
- science xix–xxi, 5–6, 10–13, 120–124, 177–181, 201–203; and the Acheulean handaxe 241–242; and cumulative culture 296–297, 303–305; and expert technological cognition 261–263; and the origins of innovation 302–303; and overimitation 297–300, 300; and ritual 296, 300–301, 305–306; and social motivations 301–302
- schizoaffective disorder 455
- schizophrenia 4, 15, 50, 452, 462; shamans and 465n2
- scientific method xix, 303, 306

- secret society 436–437, 445–447; and compliance 443–445; and ideological claims 440–443; and motives 437–440
- self-awareness 15, 501
- self-handicapping 125
- self-other reorganization (SOR) 220
- selfishness 9, 94, 101, 105
- sex: sexual behavior 74, 389, 400–402, 407; sexual competition 356, 358; sexual conflicts 389; sexual culture 14, 406, 408–409; sexual selection 60, 363, 370, 404; sexual strategies 455; *see also* females; males; reproduction
- Shandihar Cave 485
- Shoshone 457, 459
- Siberia 165, 348, 406, 453, 488–489
- Skhul 160, 345, 347, 518, 522
- Socrates 455
- Stone Age 4, 179; Middle Stone Age 138, 158, 226, 252, 365–367; Later Stone Age 161; *see also* Neolithic
- suicide 454, 499–509
- Surplus Resource Theory 10
- taphonomic 418, 520; taphonomic factors 248
- team sports 61
- technical cognition 12, 261–262, 264, 279–280, 528; and expertise 267; and Geshen Benot Ya’aqov 274–277, 275; and Lokalele 2C 271–274, 272; and nonhuman primate tools use 267, 271
- template theory 266–267, 271, 274, 276, 279
- teratogens 477, 480–481, 484
- terror 437–439, 443–445
- theory of mind (ToM) xxii, 10, 15, 533; and the Acheulean handaxe 251, 255; and generativity 145; and hormonal mechanisms for human family relationships 59, 61, 77; and learning and memory in humans 199, 208–210; and life history evolution in hominins **41**, 43, 46; and ritual 334; and suicide 501; and transitions in the archaeological record 230
- thought 137–139, 144–145, 202–203, 211–215, 222–230, 233; analytical thought 227; associative thought 227–228
- tobacco (*Nicotiana sp.*) 15, 474–478, 478, 481, 484–492, 490
- Tomasello, M. 139, 202–203
- tool use 187–190, 267–271, 278–279
- tribal grouping 162
- tribalism 337
- Turkana boy 24, 48
- Turkey *see* Göbekli Tepe
- umbrella plans 263, 276
- Upper Palaeolithic 16, 215, 222, 226–232, 435–436, 447; and hominin mortuary activity 513–514, 518–523, **519**; and madness 451–452, 459–464, 465n1; and prehistoric sexuality 407, 410; and ritual 345–347
- vasopressin 63; arginine-vasopressin (AVP) 66–67, 71–72, 74–75
- vision 203–205; *see also* perception
- vision quests 457, 485–486
- visual cortex 46, 245, 252
- visuospatial 243, 249
- Völkerpsychologie* 5, 8
- warfare 106, 336, 435–436
- worldview 110, 115, 196–198, 228–230, 234
- Wundt, Wilhelm 3–8, 16, 532
- Wynn, Thomas xxii, 12, 221, 241–243, 248, 277, 424, 527, 529
- xenophobia 10, 125
- Yaka 368–369
- Yoruba 464



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